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NORTH ATLANTIC REGIONAL WATER RESOURCES STUDY. APPENDIX Q. EROS--ETC(U)
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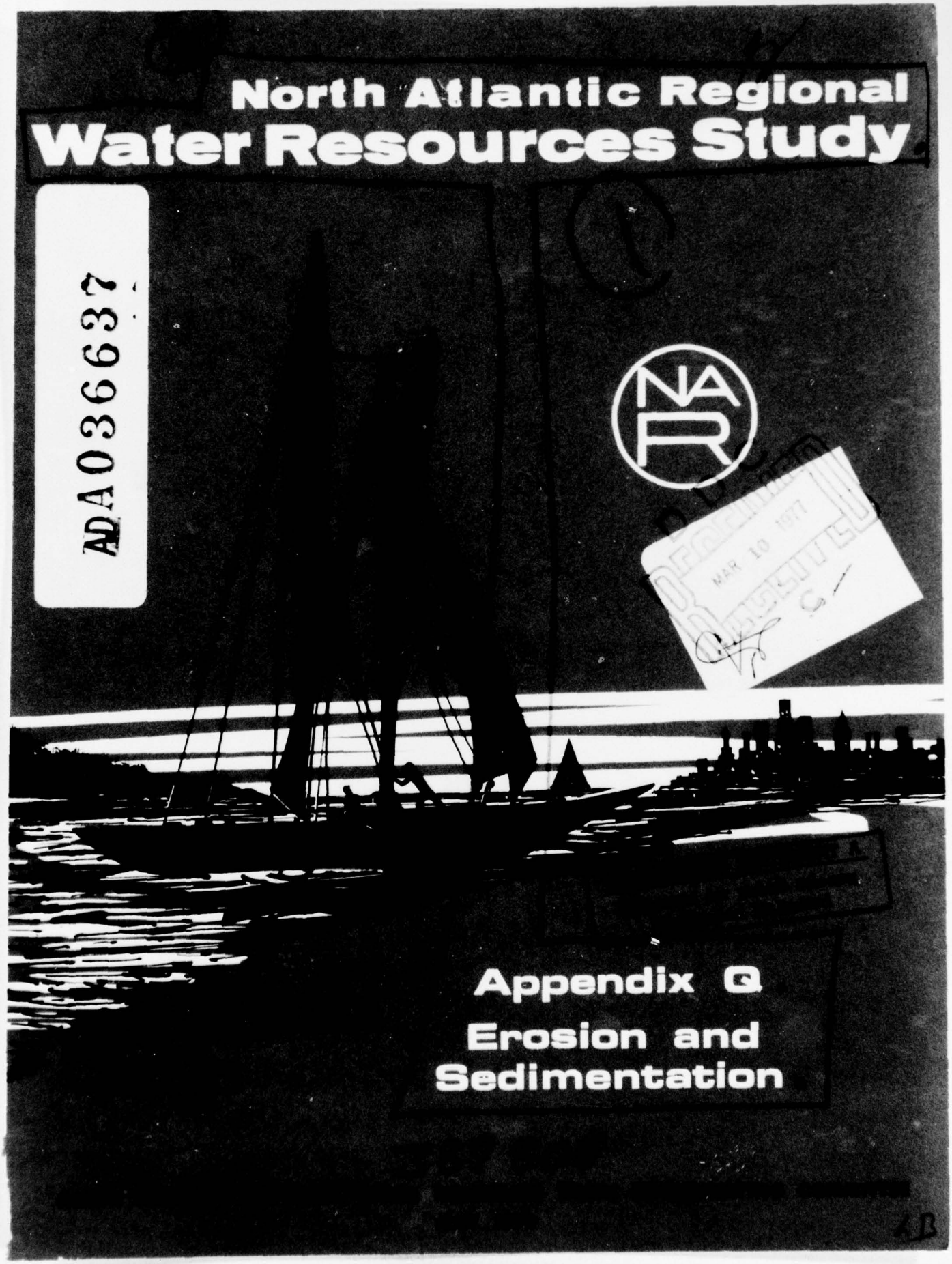
North Atlantic Regional Water Resources Study



Appendix Q
Erosion and Sedimentation

The North Atlantic Regional Water Resources (NAR) Study examined a wide variety of water and related land resources, needs and devices in formulating a broad, coordinated program to guide future resource development and management in the North Atlantic Region. The Study was authorized by the 1965 Water Resources Planning Act (PL 89-80) and the 1965 Flood Control Act (PL 89-298), and carried out under guidelines set by the Water Resources Council.

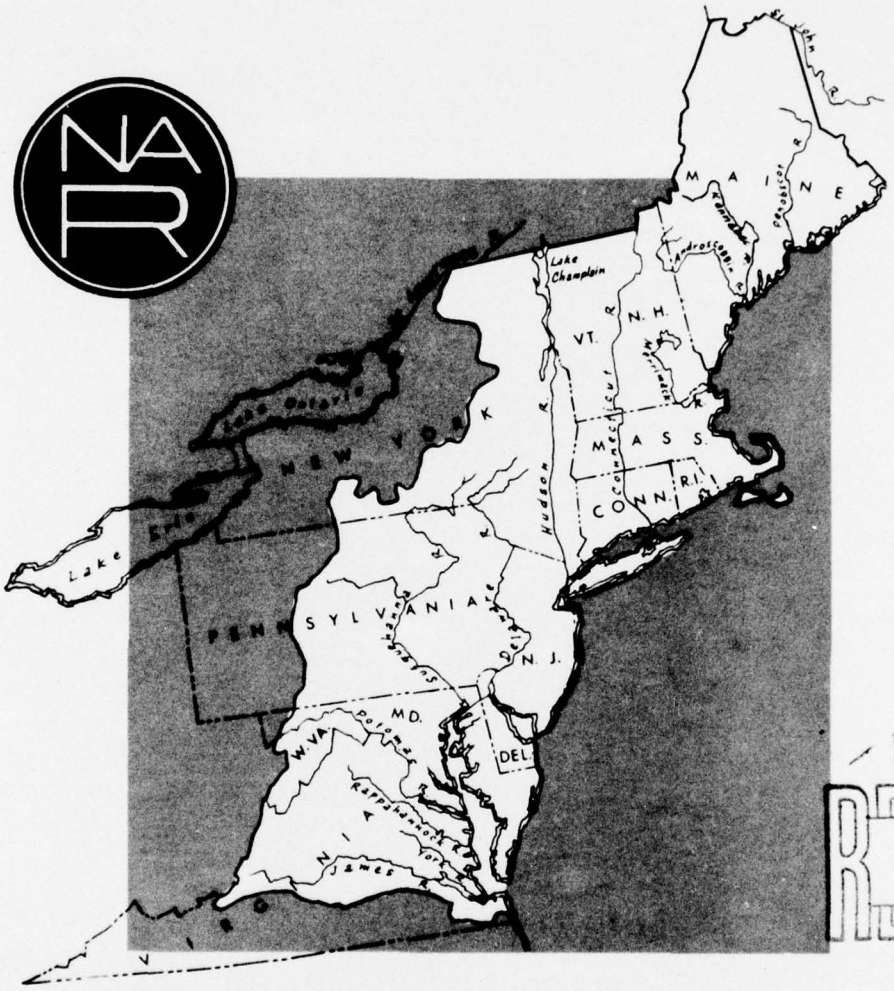
The recommended program and alternatives developed for the North Atlantic Region were prepared under the direction of the NAR Study Coordinating Committee, a partnership of resource planners representing some 25 Federal, regional and State agencies. The NAR Study Report presents this program and the alternatives as a framework for future action based on a planning period running through 2020, with bench mark planning years of 1980 and 2000.

The planning partners focused on three major objectives -- National Income, Regional Development and Environmental Quality -- in developing and documenting the information which decision-makers will need for managing water and related land resources in the interest of the people of the North Atlantic Region.

In addition to the NAR Study Main Report and Annexes, there are the following 22 Appendices:

A. History of Study
B. Economic Base
C. Climate, Meteorology and Hydrology
D. Geology and Ground Water
E. Flood Damage Reduction and Water Management for Major Rivers and Coastal Areas
F. Upstream Flood Prevention and Water Management
G. Land Use and Management
H. Minerals
I. Irrigation
J. Land Drainage
K. Navigation
L. Water Quality and Pollution
M. Outdoor Recreation
N. Visual and Cultural Environment
O. Fish and Wildlife
P. Power
Q. Erosion and Sedimentation
R. Water Supply
S. Legal and Institutional Environment
T. Plan Formulation
U. Coastal and Estuarine Areas
V. Health Aspects

Appendix Q
Erosion and Sedimentation



Prepared by

Economic Research Service, Forest Service

and Soil Conservation Service

United States Department of Agriculture

for the

NORTH ATLANTIC REGIONAL WATER RESOURCES STUDY
COORDINATING COMMITTEE

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I - SYLLABUS

This appendix presents the erosion and sedimentation problems in the North Atlantic Region (NAR). Annual erosion damages total more than $54.6 million - $53.4 million from sheet erosion, $1.2 million from streambank erosion, and unestimated amount from shoreline erosion. The resulting annual sediment damage is estimated to be about $29.3 million - $28 million the direct result of sheet erosion and $1.3 million from streambank erosion.

These monetary damages are a measure of land losses and sediment removal. Damages to visual quality of the environment, water quality, and established ecologies also are caused by erosion and sedimentation.

Erosion rates are higher in the southern part of the Region than they are in the north. Erosion rates vary from 154 tons per square mile in the Subregion A, Area 4 to 1645 tons per square mile per year in Subregion D, Area 14. Subregions D, E, and F are the specific parts of the region which are experiencing the greatest problems from sheet erosion. The same three subregions have the major occurrences of streambank erosion with the worst being in Subregion F. Critical shoreline erosion is especially severe along the New Jersey (Area 16) and New York (Area 13) coastlines. Sediment damage areas correspond to those subregions which are experiencing the erosion problems.

Sheet Erosion problems are more prevalent in the southern part of the region because (1) soils are more erodible, (2) rainfall is more intense, and (3) a higher degree of use is made of the land. Although there is some erosion from all land not made impermeable by man, most of the erosion and resulting sedimentation is from cropland, land undergoing urban development and "other" land. Because of the concentration of the problems in the southern part of the NAR (70 percent of the total sediment yield), any future studies should concentrate on Subareas D, E, and F.

In all of these cases, the activities of man have caused an acceleration of the erosion rates. Soil losses from the above mentioned land range from 3 tons per acre per year to 15 tons per acre per year and rates as high as several hundred tons per acre from developing urban areas. Although erosion rates drop as land goes into the transitional stage between agricultural and urban use, there is a sharp increase as development begins. Rapid development of urban areas associated with the Boston-New York-Washington megalopolis is creating a large part of the erosion and sedimentation problem. Much of the remaining problem is caused by the shorter rotations on cropland and the lack of use of conservation practices.

Streambank erosion problems occur throughout the region but are more common in the southern part because of lower bank resistance, greater discharges, and higher value damageable property. Shoreline erosion problems caused by ocean current and storms are most prevalent on low sandy beaches. The developed shoreline stripped of natural barriers and unprotected by man-made barriers are particularly vulnerable.

Increased populations require facilities in which to live, work, and play. The requirements of food and fiber and construction of required facilities will nearly double in the NAR in the next half century. Erosion and sedimentation problems will continue to increase in the NAR. The average soil loss is expected to increase from 917 to 1237 tons per square mile per year by 2020.

Solutions to the erosion and sediment problems fall into three categories. Broad-base planning and implementation of these plans help avoid misuse of land unsuitable for cultivation or development. Land treatment measures can be utilized to keep the soil on the land. Finally, structural measures can be used to modify conditions in cases where major damage areas exist.

Land use adjustments could reduce erosion rates and sediment yields by 10 percent. Provisions need to be made to preserve protective cover on high hazard areas. Resource plans are necessary to bring about land use adjustments and keep desirable land uses.

If the conservation land treatment program is accelerated, erosion and sedimentation yields will still increase, but at a slower rate. With a suggested accelerated land treatment program, the average annual erosion rate is expected to be 983 tons per square mile by 2020.

Structural measures protect reaches of shoreline and streambank or particular areas otherwise vulnerable to erosion.

Man's activities have accelerated the natural geologic process to an unnatural ruinous process. Adjustments and preservation of land uses, the application of conservation and treatment measures, and utilization of combination of these solutions are ways man can control the erosion and sedimentation problem.

II - INTRODUCTION

This is one of 22 subject appendices to the Main Report of the North Atlantic Regional Water Resources Study (Type I). The coordinated comprehensive Study provides a framework into which can be fitted projects and programs designed to best serve water and related land resource needs of people in the region.

PURPOSE AND SCOPE

The purpose of this study is to make an appraisal of the erosion and sedimentation problems in the North Atlantic Region ~~(NAR)~~.

The Appendix defines erosion and sedimentation problems and discusses the areal distribution, magnitude, variability and projections of future erosion and sedimentation problems for the years 1980, 2000 and 2020.

The effects of erosion and sedimentation on agriculture, municipal and industrial water supplies, reservoirs, transportation facilities, recreation, and fish and wildlife are discussed. Erosion and sediment damages in dollars are estimated.

HISTORY

Geologic erosion has worn away and sculptured the surface of the earth since time immemorial. This process of nature has formed the landscape as we know it today. Natural erosion, a slow and steady process, is a normal condition. Natural or geologic erosion is a continuing process and will go on into the future regardless of anything man can do. Quickening of the pace of erosion, owing to changes wrought by man, has produced definitely abnormal conditions. Accelerated erosion, an abnormal and undesirable process, was started by man's activities and is subject to his control.(1)

Early Trends

Ocean coasts of the NAR have experienced dramatic erosion. Hog Island, one of the southern barrier islands, has lost as much as 50 feet a year. Clearing of woodland along the shore to make way for new developments has left the shoreline vulnerable to wind and wave action. Storm waves, storm tides and tidal currents, winds and swells cause significant coastline changes rather than day to day action of littoral forces. Measurements beginning in the late 1830's record shorelines receding, remaining stable, and advancing seaward. The 1840-1870 period was predominantly one of recession, along the Delmarva Peninsula and Jersey Coast. The rocky coastline of northern New England is less susceptible to erosive process; it takes longer to make sand and gravel of schist and gneiss.(2)

From 1620 to 1860 erosion became a major problem on many American farms. The New World settlers, after a few years of farming, found that wind, rainfall and runoff injured the rocky hillsides of New England and the erodible soils of the Southern and Middle Atlantic states. By 1760 many fields were becoming barren, farms were abandoned, and in the older settled regions, erosion was more generally noticed. By 1775 rivers which once ran clear were described as being black with mud. Many references to worn out land provide evidence that sheet erosion was taking its toll.(3)

Rapid runoff from cleared land increased streamflows. Fast-moving water undercut streambanks on the outside curves causing the bank to slough and slump into the river. Streambank gullying was noticed at fords, livestock watering holes, and banks passing through new farmland. Except to specific bank locations, streambank erosion caused little concern.

Early conservationists formed agricultural societies and organizations to awaken interest in farm improvement. Books, pamphlets and farm journals were printed and widely disseminated. The leaders played a large part in agricultural reform.

The cropping system was a chief cause of erosion. Corn, tobacco and other row crops were planted repeatedly on the same land until the farmer was faced with declining yields.

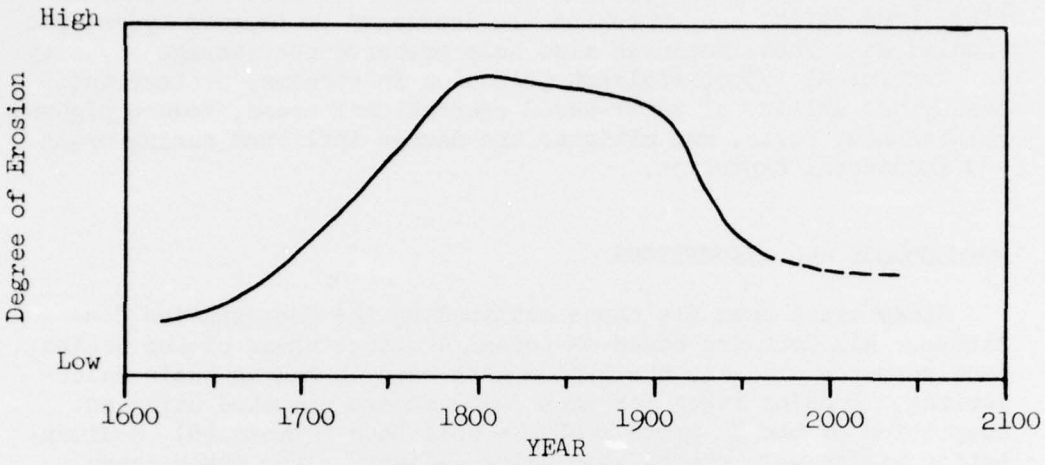
Soil maintenance required the use of mechanical techniques. Plowing, furrowing, ridging, ditching and draining were not considered the basic remedies for erosion but they did play a large part in the early American erosion control movement.

Most of the cover crops recommended by the early conservationists are widely advocated and used today. All of the conservationists urged farmers to plant grasses to reduce runoff and change the structure of the soil so that the soil particles would adhere to each other and not blow or wash away. Grass also increased the capacity of soil to produce larger crop yields.

Many of the crop rotations developed by the early soil conservationists are in use today. They anticipated the principle of the modern basic rotation consisting of a cultivated crop, a small grain, and a legume or grass. Rotations were varied in relation to the soil, slope, and climate of different sections of the country.

Before the Civil War soil conservationists recommended and employed the turning under of green crops and the introduction of animal and mineral fertilizers. These are standard practices today.(3)

FIGURE Q-1 GENERAL EROSION TRENDS SINCE 1600



Over a century ago conservationists called the attention of farmers to the dangers of erosion in this country and correctly analyzed its social, economic, and physical causes. They also pointed out the danger of exploiting the land for cash crops and the necessity for government cooperation in soil conservation.

Recent Trends

The soil and water conservation movement began to mature in the decade beginning in 1928. This era saw the establishment of soil and water conservation programs within the USDA in research and operations. These programs evolved as major bulwarks in the conservation and development of the land and water resources of the nation.

About 10 years ago data from all cooperative soil erosion studies were assembled at the Indiana Agricultural Experiment Station where a digital computer was used to study key determinants in soil loss. The Indiana findings (4) showed that erosion can be quantitatively related to the energy available for dislodgement and transport of soil particles. Energy sources are falling raindrops, and the elevation differences of sloping land which impart energy to runoff water as it flows downslope to stream channels.

A soil loss prediction handbook (4) was developed to determine potential soil loss. In addition, effective control measures have been developed that include using crop or residue covers to intercept the falling raindrops and promote water intake, planting sod crops and crop row barriers to reduce runoff velocity, and modifying the topography to reduce slope steepness and length.

The conclusions of the Indiana study also point out the need for application of conservation practices to land areas and show the tremendous reductions that can be made in erosion and sediment yield. In addition to the conservation of the soil resource for food and fiber production, such measures are necessary to improve hydrologic conditions. These measures also help preserve the storage capacity in reservoirs, reduce sediment pollution in streams, protect the beauty and utility of water-based recreational areas, reduce highway maintenance, costs, and mitigate the damage inflicted during urban and industrial expansion.

METHODOLOGY AND ASSUMPTIONS

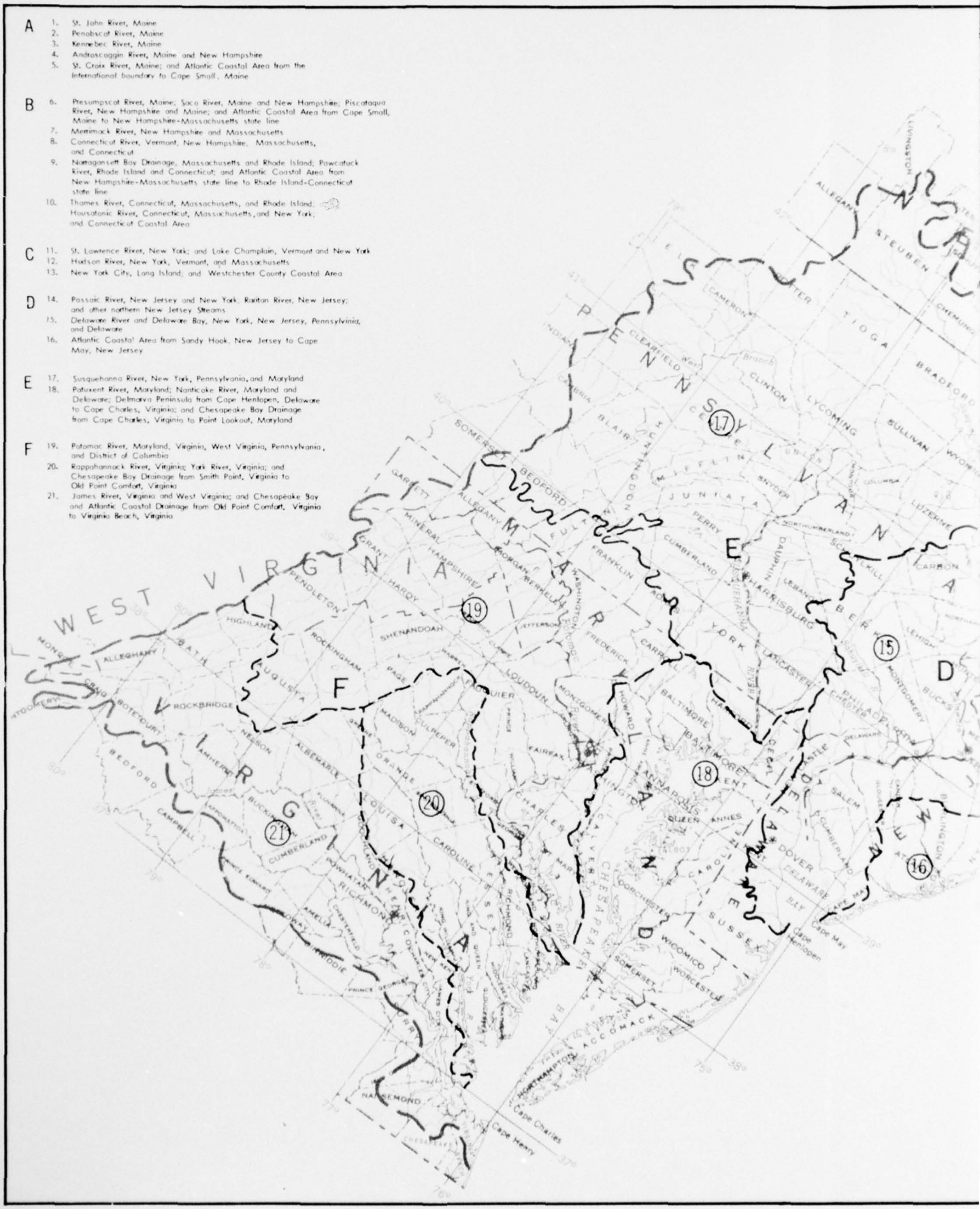
Study areas used are those outlined by the Coordinating Committee. All data are based on actual drainage areas of the Basins. Land resource areas in the Region were used in making basic calculations. Erosion rates for each land use are computed using an adaptation of the Musgrave Probable Soil Loss formula.(5) Sedimentation yields were established using delivery rates established from data in other River Basin Surveys in the Region. Erosion and sedimentation projections were made for 1980, 2000 and 2020. From this information, problem areas were delineated and the damages, benefits and costs were established. An assessment of streambank erosion and investigation of shoreline problems and remedial action were taken from recent studies.

Delineation of Study Areas

This study used the delineations of 21 areas grouped into six subregions as established by the North Atlantic Regional Water Resources Study Coordinating Committee. Figure Q-2 shows the location of these areas.

Many of the calculations are based on weighted averages of the various areas. Regional and Subregional averages are based on the drainage areas shown in Table Q-1.

Data from the 17 major land resource areas (6) in the NAR were used to compute erosion rates and establish an inventory of data. These major land resource areas are shown in Figure Q-3. Land resource areas are characterized by similar patterns of soil (including slope and erosion), climate, water resources, native vegetation, and land use. A detailed description of each area is included in Appendix G, "Land Use and Management".


A
1. St. John River, Maine
2. Penobscot River, Maine
3. Kennebec River, Maine
4. Androscoggin River, Maine and New Hampshire
5. St. Croix River, Maine; and Atlantic Coastal Area from the International boundary to Cape Small, Maine
B
6. Presumpscot River, Maine; Saco River, Maine and New Hampshire; Piscataqua River, New Hampshire and Maine; and Atlantic Coastal Area from Cape Small, Maine to New Hampshire-Massachusetts state line
7. Merrimack River, New Hampshire and Massachusetts
8. Connecticut River, Vermont, New Hampshire, Massachusetts, and Connecticut
9. Narragansett Bay Drainage, Massachusetts and Rhode Island; Pawcatuck River, Rhode Island and Connecticut; and Atlantic Coastal Area from New Hampshire-Massachusetts state line to Rhode Island-Connecticut state line
10. Thames River, Connecticut, Massachusetts, and Rhode Island; Housatonic River, Connecticut, Massachusetts, and New York, and Connecticut Coastal Area
C
11. St. Lawrence River, New York; and Lake Champlain, Vermont and New York
12. Hudson River, New York, Vermont, and Massachusetts
13. New York City, Long Island; and Westchester County Coastal Area
D
14. Passaic River, New Jersey and New York; Raritan River, New Jersey; and other northern New Jersey Streams
15. Delaware River and Delaware Bay, New York, New Jersey, Pennsylvania, and Delaware
16. Atlantic Coastal Area from Sandy Hook, New Jersey to Cape May, New Jersey
E
17. Susquehanna River, New York, Pennsylvania, and Maryland
18. Patuxent River, Maryland; Nanticoke River, Maryland and Delaware; Delmarva Peninsula from Cape Henlopen, Delaware to Cape Charles, Virginia; and Chesapeake Bay Drainage from Cape Charles, Virginia to Point Lookout, Maryland
F
19. Potomac River, Maryland, Virginia, West Virginia, Pennsylvania, and District of Columbia
20. Rappahannock River, Virginia; York River, Virginia; and Chesapeake Bay Drainage from Smith Point, Virginia to Old Point Comfort, Virginia
21. James River, Virginia and West Virginia; and Chesapeake Bay and Atlantic Coastal Drainage from Old Point Comfort, Virginia to Virginia Beach, Virginia
PENNSYLVANIA
NEW YORK
WEST VIRGINIA
MARYLAND
VIRGINIA
DELAWARE
Cape Charles
Cape Henry
Cape May
Cape Henlopen

NORTH ATLANTIC
REGIONAL WATER RESOURCES STUDY

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

October 1968

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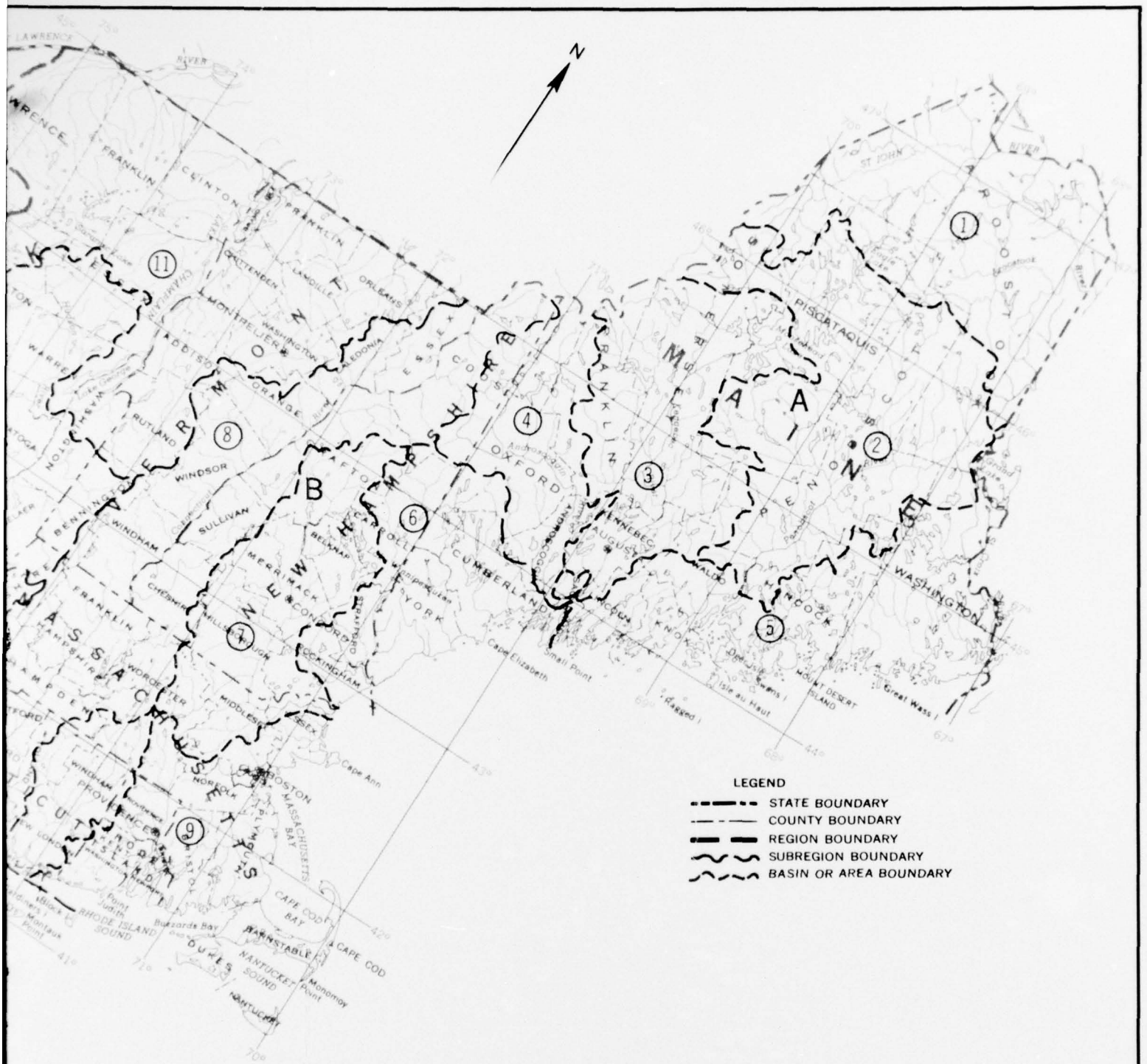
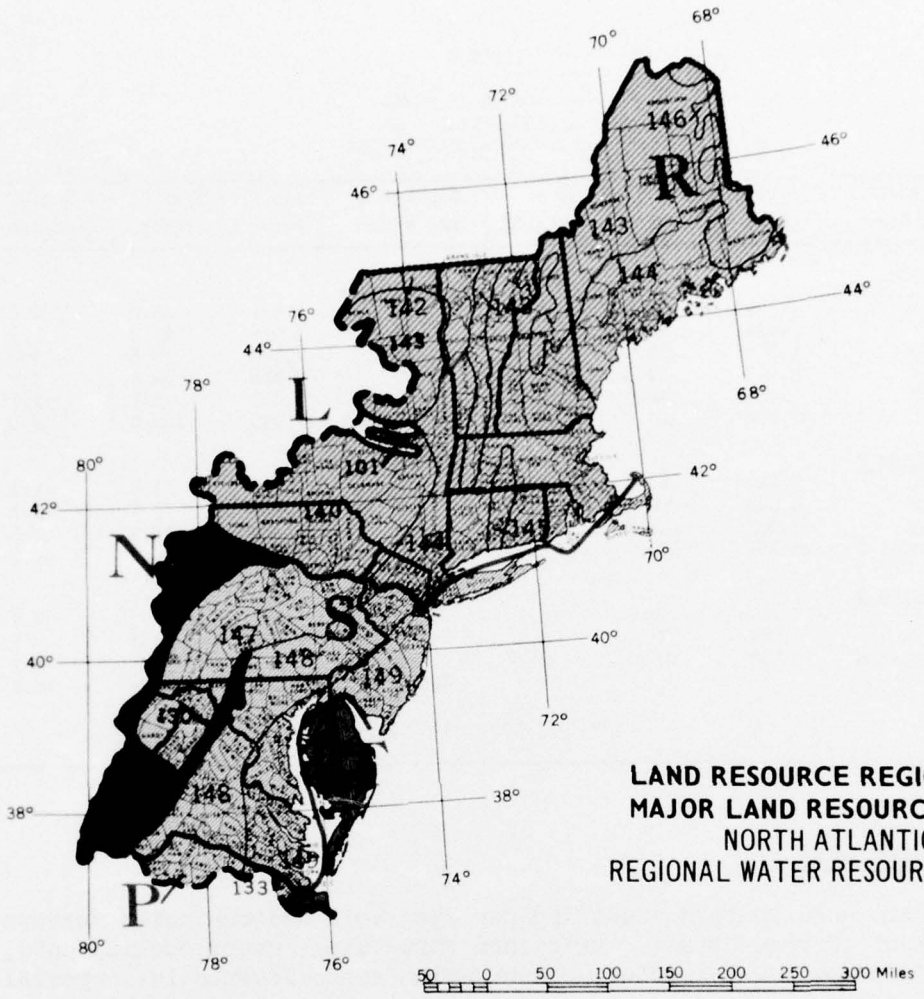


STUDY

FIGURE Q-2

USDA-SCS-HYATTSVILLE, MD. 1970

U. S. DEPARTMENT OF AGRICULTURE



LAND RESOURCE REGIONS AND MAJOR LAND RESOURCE AREAS
NORTH ATLANTIC
REGIONAL WATER RESOURCES STUDY

L LAKE STATES FRUIT, TRUCK, AND DAIRY REGION
- 101 Ontario - Mohawk Plain

EAST AND CENTRAL GENERAL FARMING AND FOREST REGION
- 127 Eastern Allegheny Plateau and Mountains
- 128 Southern Appalachian Ridges and Valleys
- 130 Blue Ridge

P SOUTH ATLANTIC AND GULF SLOPE CASH CROP, FOREST, AND LIVESTOCK REGION
- 133 Southern Coastal Plain
- 136 Southern Piedmont

R NORTHEASTERN FORAGE AND FOREST REGION
- 140 Glaciated Allegheny Plateau and Catskill Mountains
- 142 St. Lawrence - Champlain Plain
- 143 Northeastern Mountains
- 144 New England and Eastern New York Upland
- 145 Connecticut Valley
- 146 Aroostook Area

S NORTHERN ATLANTIC SLOPE TRUCK, FRUIT, AND POULTRY REGION
- 147 Northern Appalachian Ridges and Valleys
- 148 Northern Piedmont
- 149 Northern Coastal Plain

ATLANTIC AND GULF COAST LOWLAND FOREST AND TRUCK CROP REGION
- 153 Atlantic Coast Flatwoods

October 1968

Figure Q–3

USDA-SCS-HYATTSVILLE, MD. 1969

TABLE Q - 1

DRAINAGE AREAS
(TOTAL LAND AREA)
NORTH ATLANTIC REGION

Subregion and Area	1,000 Acres	% of Sub-region	% of Region	Subregion and Area	1,000 Acres	% of Sub-region	% of Region
Subregion A				Subregion B			
1	4,571	24.3	4.3	6	2,471	13.8	2.3
2	5,056	26.9	4.8	7	3,076	17.1	2.9
3	3,575	19.0	3.4	8	6,958	38.8	6.6
4	2,113	11.3	2.0	9	2,618	14.6	2.5
5	3,465	18.5	3.3	10	2,812	15.7	2.7
Subtotal A	18,780	100.0	17.8	Subtotal B	17,935	100.0	17.0
Subregion C				Subregion D			
11	7,140	43.3	6.8	14	1,472	13.6	1.4
12	8,293	50.3	7.8	15	7,965	73.4	7.5
13	1,053	6.4	1.0	16	1,409	13.0	1.3
Subtotal C	16,486	100.0	15.6	Subtotal D	10,846	100.0	10.2
Subregion E				Subregion F			
17	17,407	79.0	16.5	19	9,257	47.2	8.7
18	4,650	21.0	4.4	20	3,736	19.0	3.5
Subtotal E	22,057	100.0	20.9	21	6,639	33.8	6.3
				Subtotal F	19,632	100.0	18.5

Region Total - 105,736 acres

Existing Data

Data used in this study include reservoir sedimentation surveys, sediment storage data for watershed structures, water quality data, suspended sediment studies, conservation needs inventories, special studies and other available records. This type of information is limited in the NAR, and it became necessary to calculate erosion rates and sediment yields for this study. Existing data were used whenever possible to check the calculations for reasonableness.

Congress directed that studies be made of "the nature and scope of the damages which result from streambank erosion" and the feasibility of a program to reduce the adverse effects of streambank erosion. Material used in response to that directive was used in streambank erosion portions of this appendix.(7 and 8) Data from recent shoreline studies were used in shoreline erosion portions of this appendix.(2)

Soil Loss

Predicting soil losses involves the consideration of several factors including soil type, steepness of slope, slope length, rainfall, vegetative cover, and conservation practices. Overland erosion rates were calculated based on the relationships of G. W. Musgraves' probable soil loss formula (5), as adapted and presented in graphic form by Lloyd and Eley (9). A soil weight of 150 tons per acre inch was used to express erosion in tons.

The probable soil loss in tons per acre per year for each land use was determined by using the adapted formula in a computer program. Input data for the computer program consisted of the soil erodibility factor, slope, length of slope, rainfall and cover factor. The printout data provided the rates of erosion for the various land uses for a range of cover factors. Weighted average erosion rates based on erosion rates for the land resource areas were calculated for each of the 21 areas.

Probable Soil Loss Formula

The probable soil loss formula is expressed as follows:

$$E = F \times S^{1.35} \times L^{0.35} \times P^{1.75} \times C$$

Wherein:

E - Probable soil loss expressed as erosion in tons per acre per year.
F - Soil erodibility factor.
S - Slope of land in percent.
L - Length of slope in feet.
P - Maximum 30-minute, two-year frequency rainfall in inches.
C - Cover factor.

Soil Erodibility Factor - F. The soil erodibility factor, F, is a measure of the susceptibility of soils to destruction by erosive forces imparted through raindrop impact, wind, and moving water. Erodibility varies with the physical characteristics of the soil. Enough soils have been evaluated experimentally to enable soil technologists to make reasonably accurate comparisons and establish erodibility factors for unmeasured soils. Soils in the NAR have low erodibility factors. The weighted factor for the Region is 0.25 and ranges from 0.17 in Subregion B to 0.33 in Subregion F.

TABLE Q-2

WEIGHTED SOIL ERODIBILITY FACTORS (F)

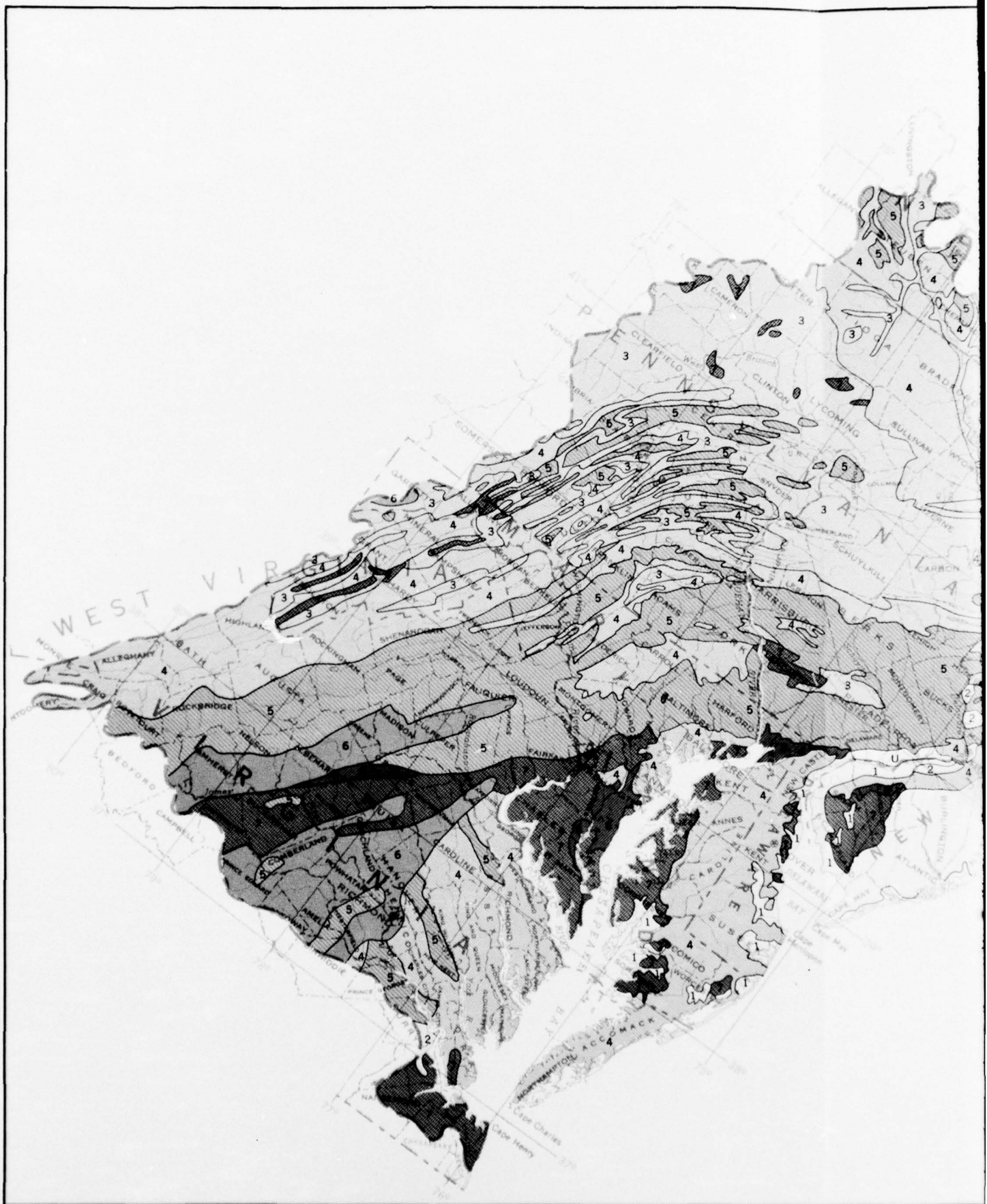
Subregion and Area	F	Average	Subregion and Area	F	Average
Subregion A			Subregion B		
1	.31		6	.17	
2	.28		7	.17	
3	.22	.25	8	.18	.17
4	.17		9	.17	
5	.19		10	.17	
Subregion C			Subregion D		
11	.20		14	.24	
12	.23	.22	15	.27	.25
13	.22		16	.20	
Subregion E			Subregion F		
17	.27	.28	19	.32	
18	.31		20	.33	.33
			21	.35	

Regional Average .25

A generalized soils map was compiled for the NAR based on existing soil association maps, problem area maps, and land resource maps. A soil erodibility factor was assigned to each of the various soil groups. Soil groups with similar soil erodibility factors were combined. (See Figure Q-4.) For each land resource area within the 21 areas, a weighted average of the soil erodibility factor was calculated. This weighted average was used in the probable soil loss formula.

Slope Factor - S. This is the average land slope in percent. The basis for determining the average slopes was the land capability subclasses. There are eight land capability classes with the limitations on use or risk of land damage becoming progressively greater from Class I to Class VIII. The subclasses describe the type of hazard or limitation and were considered. Soil slope is one of the factors used in determining land capability class.

The Inventory of Soil and Water Conservation Needs lists the acreage of the various land uses for each state and county by Land Capability Class and Subclass. The counties were grouped to approximate the 21 Areas. An average slope was assigned to each land capability subclass. A weighted average of the slope was calculated for each land use by land resource area within the 21 areas.


WEST VIRGINIA
PENNSYLVANIA
MARYLAND
VIRGINIA
DELAWARE
NEW JERSEY
ALLEGHANY
BATH
CRAIG
ROCKBRIDGE
AUGUSTA
HIGHLAND
ROCKINGHAM
SHENANDOAH
PAGE
WARREN
FAUQUIER
LOUDOUN
MONTGOMERY
HARFORD
BALTIMORE
CECIL
KENT
QUEEN ANNES
CAROLINE
CUMBERLAND
PRINCE EDWARD
AMELIA
RICHMOND
ESSEX
KING WILLIAM
NEW KENT
JAMES CITY
YORK
ACCOMACK
NORTHAMPTON
CLEARFIELD
CLINTON
LYCOMING
SULLIVAN
SCHUYLKILL
CARBON
HARRISBURG
BUCKS
MONTGOMERY
CHESTER
DELAWARE
ATLANTIC
Cape Charles
Cape Henry

SOIL ERODIBILITY

NORTH ATLANTIC
REGIONAL WATER RESOURCES STUDY

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

March 1971

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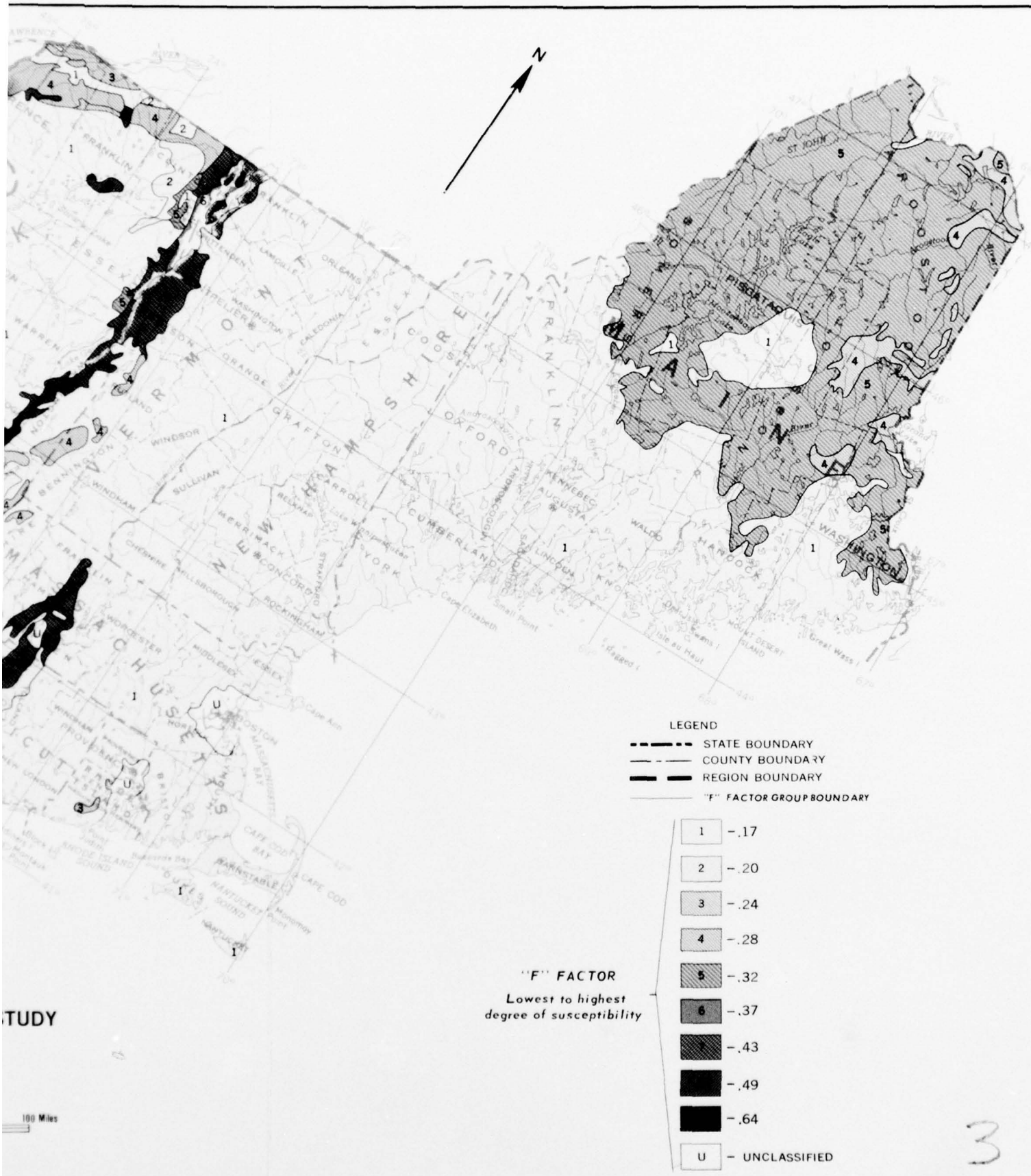


FIGURE Q-4

USDA-SCS-HYATTSVILLE, MD. 1971

TABLE Q - 3

SLOPE FACTOR (S)
NORTH ATLANTIC REGION

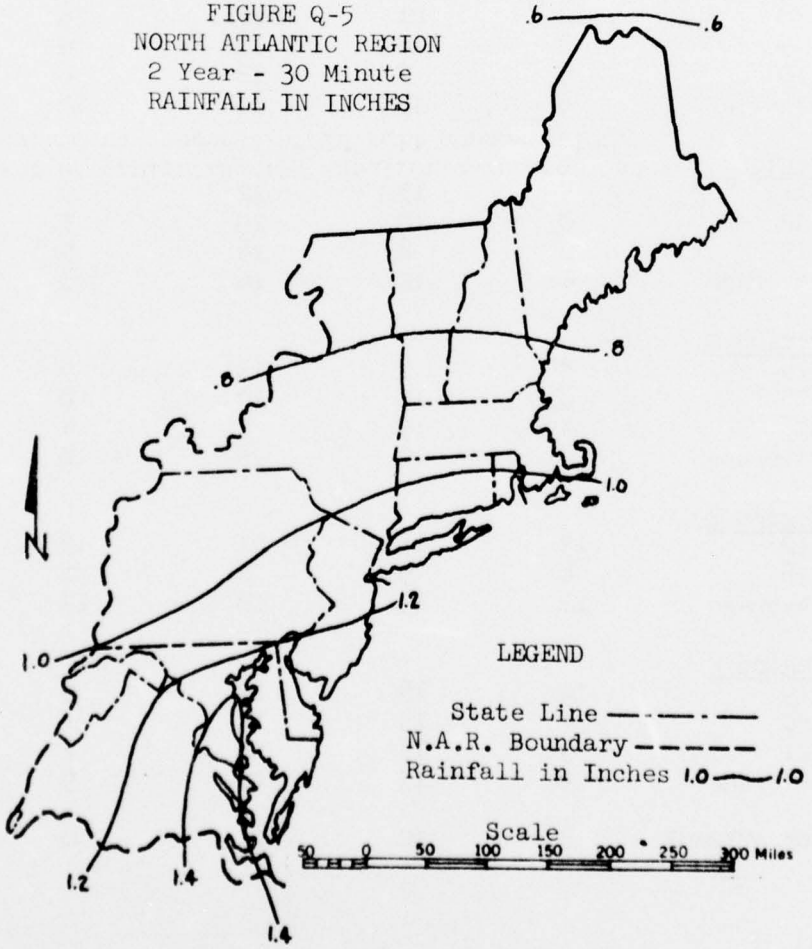
Subregion and Area	Average Slope in Percent				
	Cropland	Pasture	Forest	Urban	Other
Subregion A					
1	6	5	13	6	6
2	5	7	19	6	6
3	6	8	16	6	6
4	6	9	17	7	7
5	8	8	14	10	4
Wt. Average	6	7	16	7	6
Subregion B					
6	6	10	13	8	6
7	7	15	18	12	9
8	12	21	27	18	12
9	8	10	13	9	9
10	6	7	18	6	8
Wt. Average	9	15	20	12	10
Subregion C					
11	5	15	12	9	14
12	8	10	20	7	10
13	2	8	14	5	12
Wt. Average	6	12	16	8	12
Subregion D					
14	8	7	13	9	8
15	8	11	17	8	9
16	4	5	7	4	4
Wt. Average	7	10	15	8	8
Subregion E					
17	13	14	21	15	15
18	4	9	6	6	5
Wt. Average	11	13	18	13	13
Subregion F					
19	10	15	21	9	12
20	7	13	11	-	7
21	9	15	16	-	14
Wt. Average	9	15	17	9	12
REGION AVERAGE	8	12	17	10	10

In general the slopes of cropland, urban and other lands are gentle to moderate while the pasture and forest lands occur on moderate to steep slopes. Slope varies from 6 percent to 27 percent within the region. Table Q-3 shows the weighted averages of slopes by land use and area.

Slope Length - L. This is the average distance from the divide to a definite drainway or concentration of water. This factor is obtained from field measurements, aerial photographs or topographic maps. Consultation with numerous field personnel throughout the NAR revealed that this factor varied within the areas. Three hundred feet is the average for each area.

Rainfall Factor - P. This is based on the maximum 30-minute rainfall that is expected to occur once every 2 years. This frequency storm represents the best relationship between the maximum intensity rain in 30 minutes and the amount of soil eroded during the entire storm. Information for this factor is obtained from Weather Bureau Technical Paper 40 (10) and interpolated for each study area. (See Figure Q-5.) The range is from 0.6 inches at the northern end of Maine to slightly more than 1.4 inches in southern Virginia.

FIGURE Q-5
NORTH ATLANTIC REGION
2 Year - 30 Minute
RAINFALL IN INCHES



Easily erodable soils often become major sources of sediment. This badly eroded land is a critical sediment producer.

Long and steep slopes causes fast runoff.

Stones pedestalled 3" high indicate severity of downpour.

An anxious squirrel hunter waiting for the sight of his prey. The trees and ground cover provide watershed protection.

Cover Factor - C. This is an expression of the relative ability of different types of cover to intercept and disperse the energy of falling rain, to decrease the velocity of runoff from the ground surface and to improve the water infiltration properties of the soils. The character and density of vegetal cover appears to cause the greatest relative difference in the rate of erosion. With all things equal except cover, the rate of erosion on land used for continuous row crops may be more than 100 times as great as pasture or forest which is in good physical condition.

Cover factor values have been developed experimentally for cropland and forest. These data were used to establish cropland cover factors based on the rotations used in the different areas. Rotation information is contained in Appendix G. Estimates were made for pasture, urban and other land uses. The values used to express the effect of different cover conditions are relative to bare soil or continuous row crops with furrows up and downhill, which is assigned a value of one (1.0). In the case of urban land, consideration was given to the fact that during the urbanization period, while the soil is unprotected, cover factors are much greater than they are after the urban area has been established.

TABLE Q-4

COVER FACTOR - C

Subregion and Area	Crop-land	Crop-land treated	Wood-land	Subregion and Area	Crop-land	Crop-land treated	Wood-land
Subregion A				Subregion B			
1	.21	.11	.005	6	.02	.01	.004
2	.02	.01	.004	7	.02	.01	.004
3	.02	.01	.004	8	.082	.041	.004
4	.02	.01	.004	9	.13	.07	.005
5	.02	.01	.004	10	.078	.039	.005
Wt. Average	.06	.03	.004	Wt. Average	.07	.036	.004
Subregion C				Subregion D			
11	.02	.01	.004	14	.118	.059	.005
12	.078	.039	.003	15	.137	.069	.004
13	.273	.137	.005	16	.223	.112	.005
Wt. Average	.055	.028	.004	Wt. Average	.143	.072	.004
Subregion E				Subregion F			
17	.088	.044	.004	19	.088	.044	.004
18	.19	.095	.003	20	.101	.051	.004
Wt. Average	.119	.059	.004	21	.117	.059	.004
				Wt. Average	.097	.048	.004
	Regional Average			.100	.060	.004	

Note: For all subregions the following figures were used:

Pasture	.01	Urban Treated	.07
Urban	.20	Other	.05

The cover factors were adjusted to show the effect of adequate land treatment. It is assumed that adequate land treatment of presently untreated cropland would reduce erosion by 50 percent. This is an average figure based on data developed by Wischmeier and Smith.(4)

It is estimated that similar land treatment measures applied to urban fringe lands would reduce erosion by 65 percent. Therefore, cover factors were reduced by 0.5 and 0.65 respectively for the cropland and urban land receiving adequate land treatment. Table Q-4 gives the Weighted average cover factors developed by land use, for each area and each subregion.

Erosion Rates

The probable soil loss in tons per acre per year for each land use was determined for each land resource area. The weighted average erosion rates for the individual land uses and the average erosion rate for each area are shown in Figures Q-7 through Q-12.

Projections were made for erosion rates expected in the years 1980, 2000 and 2020. Future erosion rates were based upon (1) present levels of land treatment, and (2) an accelerated treatment program. Assumptions used in these projections are:

1. Present level of land treatment

    a. Present relationships between amounts of treated and nontreated land would persist. Land adequately treated at the present time was taken from Appendix G.

    b. Changes in acreages of various land uses are based upon historical trends. These acreages are recorded in Appendix G.

2. Accelerated land treatment

    a. Adequate land treatment would be applied on cropland halfway between presently treated and 80 percent by 1980, 80 percent by 2020, and this 80 percent would be maintained through 2020.

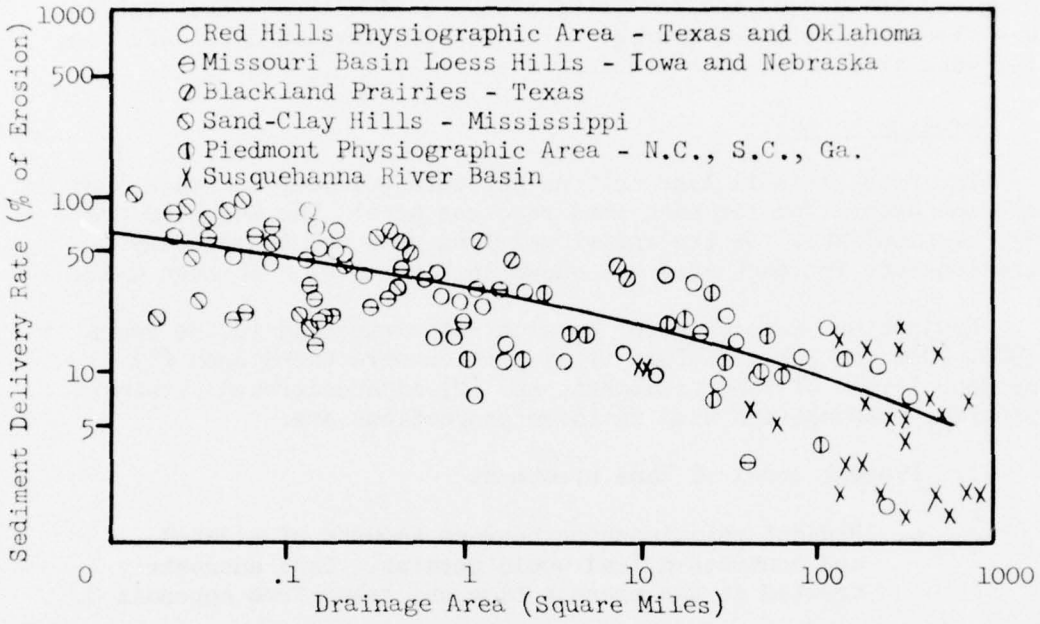
    b. Urban land treatment would affect only that land undergoing urbanization; 40 percent of land from the present to 1980 would be treated, 80 percent of the land between 1980 and 2000, and 80 percent from 2000 to 2020.

    c. Because macroscale erosion rates of other land uses are small, no attempt was made to distinguish between not treated and adequately treated.

Sediment Yields

Estimates of sediment yield are based on the average sediment delivery ratio. This ratio is the comparison of sediment yield to gross erosion, expressed as a percent of the erosion. An analysis of data obtained from studies made in the Blackland Prairies, the Red Hills, the Missouri Loess Hills, the Mississippi Sand-Clay Hills, and the Southeastern Piedmont is shown in Figure Q-6.(11)

FIGURE Q-6
SEDIMENT DELIVERY RATE VS. SIZE OF DRAINAGE AREA



The data indicate considerable variation in sediment delivery ratio for any given drainage area size. The larger the drainage area, the less soil is delivered to a particular site. However, when all the data are considered together, they also show that there is a general relationship between delivery ratio and drainage area size. Data from the Preliminary Appraisal of Stream Sedimentation in the Susquehanna River Basin (12) were plotted on Figure Q-5. These data provide additional information and validate the usefulness of this curve in the NAR.

Delivery ratio for the NAR was determined by comparing the erosion rates in this appendix with sedimentation data in the Delaware River Basin Report (13), Potomac River Basin Report (14), and the U. S. Geological Survey Open File Report entitled Preliminary Appraisal of Stream Sedimentation in the Susquehanna River Basin (12). Average delivery ratios for these basins obtained from these reports were 10.1, 8.3, and 7.3 respectively. A ratio of 7.5 was used in this study.

The projected sedimentation yields for 1980, 2000 and 2020 were prepared by multiplying the delivery ratios times the projected erosion rates for the levels of land treatment.

Streambank Erosion

To complete the "National Assessment of Streambank Erosion", Soil Conservation Service personnel in conjunction with the Corps of Engineers, from all parts of the Region provided information on the amounts of streambank erosion in their areas. Stream density by land resource area was used to determine total stream miles and bank miles. Estimates were then made on how many of these banks erosion was negligible, moderate and serious. Damages were determined at the site where erosion occurred and where the ensuing sediment was deposited. Costs of treatment were calculated for both moderate and serious cases.

Shoreline Erosion

Three reports developed by the Corps of Engineers for the "National Shoreline Study" are (1) regional inventories, (2) shore protection guidelines, and (3) shore management guidelines. The regional inventories are descriptions and tabulations from many sources. The entire 8,500 miles of shoreline were classified as stable or unstable and in the latter category as either critical or noncritical. Costs were established for various levels of treatment.

Problem Area Delineation

Problem areas fall into two general categories - onsite and offsite. Onsite problem areas include cropland where soil erosion results in losses in productivity and increased production costs, urban land where large amounts of soil are lost, and eroding streambanks and shorelines which are total losses of land. Offsite problem areas are usually flood plains, streams, rivers and lakes where sedimentation occurs. This often results in damage to ponds and reservoirs, water supplies, natural and constructed channels, fish and wildlife, transportation and other facilities.

Cropland where erosion rates exceed allowable soil losses are problem areas. Soil technologists have used experimental data to assign allowable losses for all soils found in the Region. This loss reflects the amount of soil that can be lost from cropland and still maintain a high level of productivity over a long period of time. These allowable soil losses range from one ton to five tons per acre. Generally, the higher losses are allowed on deep, permeable, well drained soils and the low losses on soils having unfavorable subsoil characteristics. Excessive erosion from cropland areas constitutes a problem area.

Urban areas constitute a major problem during the construction period. Residential, commercial, industrial and highway construction expose large areas of bare soil for periods from three to seven years long. Severe erosion takes place in a short time.(15) Almost all urbanizing areas are classed as problem areas.

Streambank erosion problem areas are often small and scattered. The greatest problem is the total loss of land which occurs with the erosion. In addition, foundations for buildings, utilities and fences are often undercut causing severe property damage. These areas were delineated in a 1969 study. (7)(8)

Shoreline erosion problem areas are similar to those listed under streambank erosion areas. These problems are no less severe. Unstable and critical areas originally marked by photographic survey are shown on plates in the "National Shoreline Study - North Atlantic Region".(2)

Reservoir sedimentation data show that relatively small quantities of deposition have caused sedimentation problems in small capacity ponds and reservoirs, and in the recreation pools of large reservoirs. The same is considered true for stream channels, drainage ditches, roadside ditches and catch basins. For the purpose of this appendix, all 21 areas will be considered sedimentation problem areas varying only in degree.

Damages, Costs and Benefits

Estimates of erosion damages to agricultural lands generally involve evaluating the loss of productivity, higher production costs, and social costs. The reduction in yield varies with the amount of soil which is lost. These damages may be represented by the market value of the plant nutrients contained in the soil being lost and have been estimated to have a value of $1 per ton of soil. (16) Production costs are increased where destroyed structure makes soil harder to till, and where machinery must cross gullies and unproductive land. Loss to public interests results as a poorer resource base (lower tax base).

Information on erosion damages in urban areas is limited.(17) These damages could be measured by a savings of certain development costs and greenery establishment, and preventing mud slides. It is recognized that sheet erosion does occur on other land uses, but losses are minimal. Only loss of productivity on cropland was computed in monetary terms.

Sedimentation damages are considered to be the cost of removing the sediment deposited in downstream areas. All land in the Region contributes to downstream sedimentation and is considered in measuring sediment damage. Damage occurs during transport all along streams, rivers, lakes and wherever sediment is deposited. Costs for sediment removal range from $.25 to over $3 per cubic yard removed. For the NAR Study the average removal cost is estimated to be $2 per cubic yard of sediment. Because of the increasing concern over depositing dredged material at the site where it is removed, this cost could be higher in the future if the spoil must be trucked away to special disposal sites.

Streambank erosion damages are the result of land voiding. Damage values were developed for urban and agricultural land. Actual and potential land use of the eroded area were used in assigning the damageable value to the acreages - high value land $600 per acre, medium value $300 per acre, and low value $50 per acre. Estimates of damage to other properties were made. Downstream or sedimentation damages were estimated based on an average loss of soil per mile of eroding bank. Approximately $30 per mile of erosion was used for computing offsite damage.

The nature of shoreline erosion and the constant shifting of sands made estimates of erosion damages beyond the scope of the Corps study.(2) Areas of damage were classed as critical and noncritical.

Costs for land treatment were based on expenditures by landowners and operators to adequately treat an acre subject to erosion. Conservation treatment includes: diversions, stripcropping, cover cropping, trail and roadside stabilization, establishment and re-establishment of grass, shrubs, and trees, and wildlife habitat development and preservation. The initial cost of this treatment shown in Appendix G is from $25 to $100 per acre.

Costs for streambank protection were estimated to be $12,000 per bank mile for vegetative treatment, $120,000 per bank mile for riprap, and $400,000 per bank mile of lined channel. Shoreline protection costs range from $185,000 per mile for a simple sandfill to $2.6 million for more extensive work which might include piling and jetties.

Benefits are based upon the reduction of erosion and ensuing sediment. Onsite monetary benefits to cropland were computed using $1 for every ton of soil retained. Offsite monetary benefits were computed using $2 for every cubic yard reduction in sediment. Streambank erosion benefits are the reduction in land voiding, downstream sedimentation, and loss of buildings, fences and utilities. Shoreline benefits are primarily the protection and preservation of beaches, recreational facilities, and coastlines.

III - REGIONAL SUMMARY

PRESENT STATUS

Erosion

Man's activities have speeded erosion beyond the natural geologic process to an unnatural ruinous process. Construction and good producing areas are the major sources in the NAR of 151 million tons of soil lost each year. Streambanks and shorelines denuded of vegetation are eroding. Unnatural speeded erosion is subject to man's control.

Kinds

Erosion by water can be divided into three broad categories: (1) overland erosion, (2) channel erosion, and (3) shoreline erosion. Each category can be further divided into several kinds of erosion.

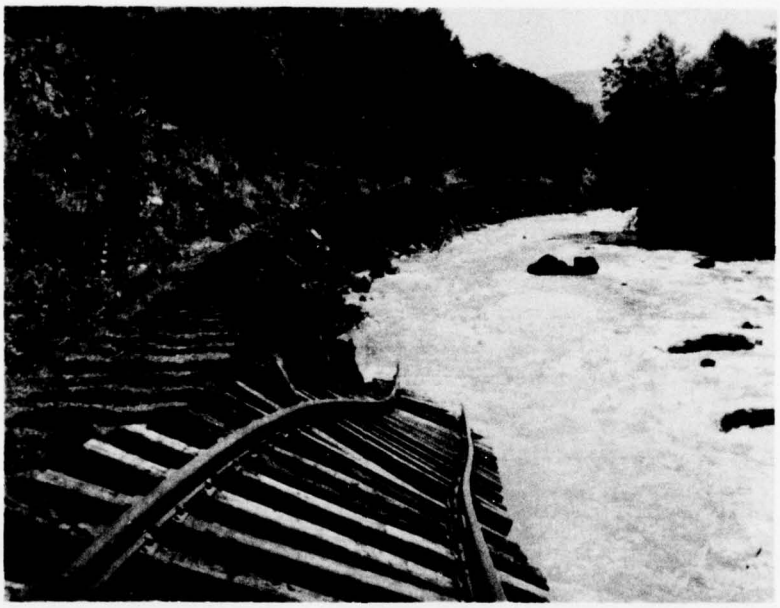
Overland Erosion. Overland erosion includes sheet erosion by both wind and water. Sheet erosion (including rill erosion) by water is defined as the removal of a relatively uniform depth of soil or soil material from the land surface by runoff flowing over the land surface without the formation of major channels. Sheet erosion by wind occurs when winds pick up and transport loose, dry, finely divided soil particles from smooth, bare fields. This type of erosion generally occurs on cultivated loose sands or light, silty soils.

About 75 percent of soil losses in the NAR are from sheet erosion.

Channel Erosion. Channel erosion is defined as the removal of soil and rock by a concentrated flow of water and includes gully erosion, streambank erosion, streambed degradation, flood plain scour, valley trenching and, to some extent, roadbank erosion.

Gully erosion occurs when sheet and rill erosion progresses to the point where a major depression is formed. Not only is a large amount of valuable soil lost, but fields are segmented and equipment cannot cross the gully during farming operation.

Streambank erosion occurs widely throughout the Region. It is not significant when considered as part of the entire NAR. On a local basis where the stream is eroding the banks bordering good agricultural land, the loss may be significant to the landowner. Much of the flood plain land is used less intensively than is potentially possible. This is because of the streambank hazard.



Undercut banks cause land voiding and property damage

Streambed degradation occurs when the bed of the stream is eroded either because the gradient of the stream has been changed or a major storm has caused the protective bedload cover to be removed and the bottom eroded. Degradation is not generally noticed, but can result in a lowering of the water table in the area around the stream.

Flood plain scour occurs when a stream overflows its banks and cuts a temporary or high stage channel into the flood plain. Depending on the time of year this can result in the loss of a crop as well as the fertile topsoil.

Valley trenching is the cutting of a new channel by the streams and results in a total loss of land. Cultivation is generally not possible on these lands.

Shoreline erosion. This kind of erosion is the result mainly of storm waves and currents, although runoff also contributes to the problem. Large amounts of land are lost each year - more than two feet per year in some cases. Even more dramatic are the losses where high banks are eroded. A detailed discussion of this problem is found in Appendix U.

Lighthouse with eroding glacial till bluff is now several hundred feet closer to the edge.

Rates

In the NAR sheet erosion and channel erosion are all active at varying rates. Results of studies on watersheds throughout the United States show that overland erosion is the largest source of sediment. This is generally the case in more humid parts of the country (18) and applies to the NAR.

The rate of sheet erosion depends on soil type, topography, rainfall and cover conditions. The soils in the NAR generally have a low erodibility factor. The weighted average soil erodibility factor is 0.25 and ranges from 0.17 in Subregion B to 0.33

in Subregion F (Table Q-2). In general, the slopes of the cropland, urban, and other lands are gentle to moderate while the pasture and forest lands occur on moderate to steep slopes (Table Q-3). There is considerable variation in the rainfall factor. Figure Q-5 shows the maximum 2-year, 30-minute rainfall. The range is from 0.6 inches at the northern tip of Maine to a little more than 1.4 inches in southern Virginia.

The greatest relative difference in the rate of erosion comes from changes in the cover factor. The cover factors used in the NAR Study (Table Q-4) are relatively uniform throughout the Region with the exception of cropland. This is due largely to more intensive agriculture in Subregions D, E, and F. In the New England area several years of hay in the crop rotations result in considerably lower cover factors.

Estimated present gross erosion rates for all land in the NAR are shown in Table Q-5. A sharp contrast exists in the amount of erosion in the northern section (Subregions A, B, and C) of the Region and the southern section (Subregions D, E, and F). There are several reasons for this: (1) soils in the New England area are less erodible, (2) rainfall factor is lower in the north, and (3) most of the land is forest or grass covered in the area with the lower rates.

TABLE Q-5

GROSS EROSION FROM ALL LAND
PRESENT CONDITIONS
NORTH ATLANTIC REGION

Subregion and Area	Total Acres (Million)	Tons/ Sq.Mi./ Yr.	Tons/ Ac./ Yr.	Subregion and Area	Total Acres (Million)	Tons/ Sq.Mi./ Yr.	Tons/ Ac./ Yr.
Subregion A				Subregion B			
1	4.6	173	0.27	6	2.5	192	0.30
2	5.0	166	0.26	7	3.1	486	0.76
3	3.6	186	0.29	8	7.0	390	0.61
4	2.1	154	0.24	9	2.6	762	1.19
5	3.5	166	0.27	10	2.8	410	0.64
Subregion C				Subregion D			
11	7.1	205	0.32	14	1.5	1645	2.57
12	8.3	550	0.86	15	8.0	1562	2.44
13	1.0	1242	1.94	16	1.4	685	1.07
Subregion E				Subregion F			
17	17.4	1504	2.35	19	9.3	1574	2.41
18	4.7	1626	2.54	20	3.7	1152	1.80
				21	6.6	1530	2.39

Total Land Acreage - 105.7 million acres

All of the rates shown in Table Q-5 are relatively low because there are large acreages of land with good cover conditions which protect against erosion. Forest and pasture land have very low erosion rates and constitute a large percentage of the total land use. This masks the fact that cropland and urban land have much higher rates.

Although cropland comprises only 15 percent of the land use in the Region, substantial amounts of soil are being lost from this acreage. Table Q-6 gives the acreage and the erosion rates for cropland. These average rates include 6.2 million crop acres not subject to erosion as well as 9.8 million crop acres on which erosion is a dominant problem. Approximately 40 percent of the 16 million acres is adequately treated.

TABLE Q-6

GROSS EROSION FROM CROPLAND
PRESENT CONDITIONS
NORTH ATLANTIC REGION

Subregion and Area	Total Acres (1000)	Tons Sq.Mi./Yr.	Tons/Ac./Yr.	Subregion and Area	Total Acres (1000)	Tons Sq.Mi./Yr.	Tons/Ac./Yr.
Subregion A				**Subregion B**			
1	240	1344	2.10	6	170	141	.22
2	196	122	.19	7	168	192	.30
3	287	186	.29	8	598	1197	1.87
4	132	115	.18	9	145	1645	2.57
5	215	154	.24	10	237	698	1.09
Subregion C				**Subregion D**			
11	1222	128	.20	14	229	3123	4.88
12	1296	1120	1.75	15	1811	3609	5.64
13	63	1926	3.01	16	212	2112	3.30
Subregion E				**Subregion F**			
17	4019	3392	5.30	19	1823	3757	5.87
18	1766	3565	5.57	20	582	4019	6.28
				21	636	5702	8.91

Total Cropland Acreage - 16 million acres

Urban and other lands are another main source of erosion. Acreages include bare land awaiting development, construction areas, recently urbanized and established urban land, and vacant lots, recreational areas, yards and farmsteads, unpaved roads and roadsides with poor cover conditions. Rates are much higher than for grass or forest cover. Urbanization is occurring on about .4 million of the 13.2 million acres (assumes three year development period). Rates on these areas are 9 to 15 times greater than averages shown in Table Q-7.

TABLE Q-7

GROSS EROSION FROM ESTABLISHED URBAN AND OTHER LAND
NORTH ATLANTIC REGION

Subregion and Area	Total Acres (1000)	Tons/ Sq.Mi./ Yr.	Tons/ Ac./ Yr.	Subregion and Area	Total Acres (1000)	Tons/ Sq.Mi./ Yr.	Tons Ac./ Yr.
Subregion A				Subregion B			
1	66	858	1.34	6	297	1056	1.65
2	160	813	1.27	7	461	2458	3.84
3	119	1766	2.76	8	530	2112	3.30
4	122	998	1.56	9	798	2016	3.15
5	261	1152	1.80	10	494	1216	1.90
Subregion C				Subregion D			
11	571	1402	2.19	14	610	2835	4.43
12	1091	2189	3.42	15	1647	3475	5.43
13	625	1773	2.77	16	416	1312	2.05
Subregion E				Subregion F			
17	2135	5466	8.54	19	997	4838	7.56
18	935	2445	3.82	20	354	3821	5.97
				21	555	8314	12.99

Total Urban and Other Acreage - 13.2 million acres

Trees and grass provide cover that dissipates erosive energy. With the exception of abandoned skid trails and logging roads, defoliated trees caused by disease or fire, and overused recreational areas, erosion rates from forest lands are minimal. With the exception of overgrazed and very poorly managed pastures, erosion rates from pasture are small. Forest and pasture land erosion rates are those expected from the natural, geologic process.

In the streambank erosion process, energy from streamflow, ice, floating debris, and gravity is applied to the streambank and bed. If the energy is greater than the resistance of the soil particles forming the channel, erosion results. Bank resistance is determined by its soil composition and condition. Frequent and high discharges and increased velocities are streamflow influences causing greater erosive action. The effect of stream sediment on bank erosion is related to the amount of total sediment and the ratio of bed load to suspended load. Wave action, ice flows, debris, sudden drawdown of prolonged high stages and rapidly fluctuating stages contribute to bank erosion. The flowing stream is constantly trying to establish equilibrium among its discharge; amount and type of sediment load; channel width, depth, and slope; velocity; and the material forming its bed and banks.(19)

Man's activities have influenced some of the erosion-producing factors. By reducing flood peaks with reservoirs, duration of bankfull stages downstream from the dam may be increased. By trapping

suspended and bedload sediment, released clear water alters the previous stream equilibrium. Recreational and commercial water traffic causes wave action. By encroachment, man reduces the cross-sectional area of the channel available to carry the flow of streams, thereby increasing the velocity.(19) By stripping the banks of vegetation and allowing livestock to trample down the banks, the condition of the streambank is adversely affected.

Streambank erosion rates are between 0.1 and 0.5 feet per year of lateral cutting throughout the NAR. Because the total tons lost depends on the height of the bank being eroded, no total loss figure can be established for the entire area.

Changes of the coastline and offshore depths are principally influenced by tidal, current and wave action, by the condition of the shoreline, and by the natural dependable supply of beach nourishment material to keep the shore in a stable condition. Hurricanes, ocean storms, and swells cause water action to become erosive. Shoreline construction and destruction of natural vegetation make the coastline vulnerable to the erosive processes. Shoreline varies from rocky bluffs in the north to large expanses of low, sandy beaches from Southern New England to Virginia.

Shoreline rates vary considerably from very little erosion or .1 foot per year to more than 10 feet per year. Littoral drift and other negating factors help re-establish the shoreline and a net erosion figure results. Determination of this figure must be on a very local basis and no attempt has been made in this study to determine this figure.

Sediment

Sediment, the product of the erosion process, is deposited along the flood plains and often causes damages. It can result in infertile overwash, cause swamping and increase flooding. It damages drainage improvements, water filtration plant equipment, reservoirs, transportation facilities, fish and wildlife, decreases the recreational value of water; and increases costs of industrial and municipal water treatment.

Kinds of Sediment Damages

Infertile overwash is the deposition of sand, gravel or other unproductive material on flood plains during floods. This destroys or greatly reduces the productivity of the bottom lands.

Swamping is caused by sediment deposits filling in stream channels and impairing drainage to the extent that the water table is raised, reducing crop yields in the adjacent lands. This sediment also impairs natural soil drainage and reduces infiltration. This may be caused by the formation of natural levees adjacent to

the channel which impairs flood plain drainage. Swamping also leads to increased flooding which may be caused by the decrease in channel capacity by sediment deposits. These deposits may decrease the grade or cross sectional area of the channel.

Damage may be caused to drainage improvements, channels and structures. Sediment accumulates in these structures and must be removed for these systems to remain effective.

The cost of removing sediment from municipal and industrial water is considered a damage. Damages consist of increased cost of flocculating chemicals for water treatment, damages to pumps and treatment plants, and increased time necessary to clean up the water.

The damage to reservoirs is the loss of storage capacity due to sediment accumulation. This damage is usually measured as a storage replacement cost since it is generally less expensive to build new reservoirs than it is to dredge the sediment from existing reservoirs.(20) Accumulation of sediment in reservoirs generally results in reduced downstream sediment damages due to the trapping effect of the reservoir.

The damage to transportation facilities includes damage to highways and railroads. Sediment deposited in highway and railroad ditches, culverts and bridges, as well as on the roadways, increases the cost of maintenance.

The damage to navigable streams is reflected in the cost of maintaining the required depth and width by dredging.

Sediment reduces the attraction of many streams, lakes, ponds, and reservoirs for swimming, boating, fishing and other water-based recreation activities. Sediment destroys the spawning beds of game fish, smothers their eggs and reduces their food supply. Fish eat worms, insect larvae, and other small aquatic animals that feed on microscopic plants, but muddy water shades out light, interfering with the growth of the microscopic plants. The deep pools that provide a refuge for fish during the dry season have been filled by sediment in many of the smaller streams. Many streams no longer have as many game fish as they once had. Trash fish such as carp and suckers can live in turbid water and are replacing the game fish.

Sediment has adverse effects on shellfishery resources. It not only reduces the survival capacity of the larval stages of shellfish when they are present as free floating stages in the water column, but also destroys young and adult shellfish by silt deposition. This is particularly true during the over-wintering dormant periods. It is difficult to assess these recreational and fish and wildlife losses in monetary values.

Yields

Sediment yields based on erosion vary a great deal throughout the Region. Gross erosion and sediment yield are not synonymous because of progressive deposition of eroded materials enroute from point of origin to the point under consideration in the area. Sediment yield correlates with erosion inasmuch as a decrease in erosion generally results in a decrease in sediment yield. Average rates were calculated using the delivery ratio of 7.5. Data shown in Table Q-8 give yields from all land by areas. Generally, yields are as much as 10 times greater in the southern part of the Region as they are in the northern part.

Sediment yields from sources as construction areas, roadsides, and streambanks which are in close proximity to streams are difficult to measure. Because the point of origin is so near the stream, delivery ratios are higher and thus sediment yields are greater. Heavy sediment loads cause localized damages.

TABLE Q-8

RATE OF SEDIMENT YIELD FROM ALL LAND
NORTH ATLANTIC REGION

Subregion and Area	Tons/Sq.Mi./Yr.	Wt. Average	Subregion and Area	Tons/Sq.Mi./Yr.	Wt. Average
Subregion A			Subregion B		
1	13		6	14	
2	12		7	36	
3	14	13	8	29	33
4	12		9	57	
5	12		10	31	
Subregion C			Subregion D		
11	15		14	123	
12	41	33	15	117	109
13	93		16	51	
Subregion E			Subregion F		
17	113		19	118	
18	122	115	20	86	111
			21	115	

Regional Average - 69 tons/sq.mi./yr.

The amount or concentration of sediment carried by streams is affected significantly by flow conditions. During periods of base flow, when the streamflows are maintained largely by ground water discharge, sediment concentrations are normally relatively low and change little from day to day. In small streams the water and sediment content change rapidly during periods of direct storm runoff and the runoff lasts only a short time. In the large rivers, however, the water discharge and sediment concentrations change more slowly, but the duration of a storm discharge is much longer.(21)

Problem Areas

The erosion process results in onsite and offsite damages. Erosion damages are considered onsite damages that occur to the land being eroded. Sediment damages are offsite damages usually occurring far from the site of erosion. Damages refer to loss of income or increased costs, and/or reduction in environmental quality.

Erosion

Damages occur through the loss of soil, a breakdown of soil structure, shallower depth of topsoil, and loss of organic matter. Nutrients and essential micro-organisms contained in the eroded topsoil may never be replaced on some of the more shallow soils in the NAR.

Allowable soil loss rates on cropland for many soils in the Region are about 3 tons per acre. This may vary under local conditions where a thin soil cover is present or for other reasons. Using this figure as a general guide in considering gross erosion from cropland, most of the areas south of New York have erosion problems. Because of a shallow soil, Area 1 and Area 9 with a 2.1 and 2.6 tons per acre per year soil loss is also a critical rate.

Crop yield decline and production costs increase with the loss of topsoil.

Damage from erosion occurs on most cropland in the NAR with the main difference being the degree or amount of erosion occurring. Damage of productivity loss to cropland is more than $53 million annually. As can be seen in Table Q-9, 90 percent of the damage occurs in Subregions D, E and F.

TABLE Q-9

EROSION DAMAGE TO CROPLAND
NORTH ATLANTIC REGION

Subregion and Area	Cropland Subject to Erosion			Annual Soil Loss
	Slight	Moderate	Severe	
	(1000 acres)			(1000 tons)
Subregion A				
1	136	100	4	433
2	143	51	2	30
3	183	98	6	67
4	80	50	2	19
5	155	53	7	38
Subtotal A	697	352	21	587
Subregion B				
6	84	80	6	29
7	95	68	5	51
8	344	182	72	481
9	104	39	2	279
10	134	97	6	210
Subtotal B	761	466	91	1050
Subregion C				
11	682	460	80	187
12	492	642	162	1670
13	48	14	1	103
Subtotal C	1222	1116	243	1960
Subregion D				
14	87	115	27	855
15	605	973	233	8018
16	144	63	5	490
Subtotal D	836	1151	265	9363
Subregion E				
17	834	2196	989	16819
18	1013	654	99	7868
Subtotal E	1847	2850	1088	24687
Subregion F				
19	459	1023	341	8351
20	261	245	76	2686
21	197	341	98	4685
Subtotal F	917	1609	515	15722
REGIONAL TOTAL	6280	7544	2223	53369

Cropland subject to erosion is based upon land capability class and subclass:

Slight	Cropland not in subcalss e
Moderate	IIe and IIIe
Severe	IVe through VIIIe

Expanding urban areas, especially in Subregion F, have experienced excessive soil losses as building contractors often destroy the vegetative cover. Erosion sometimes endangers buildings, undermines foundations, and destroys project works. Onsite sediment clogs storm sewers, covers roadways, and fills construction excavations. Not only is good soil lost to erosion, but the problem is somewhat compounded when the new landowner tries to establish a good protective cover on poorer soil conditions. Many of these same problems occur with highway construction when 10 to 40 acres per mile are cleared. Some steps have been taken to alleviate this situation, but more needs to be accomplished.

Excessive sediment is produced by an intense rainfall on exposed land.

Slip on I-64 closing west-bound lane of traffic, will cost $420,000 to repair.

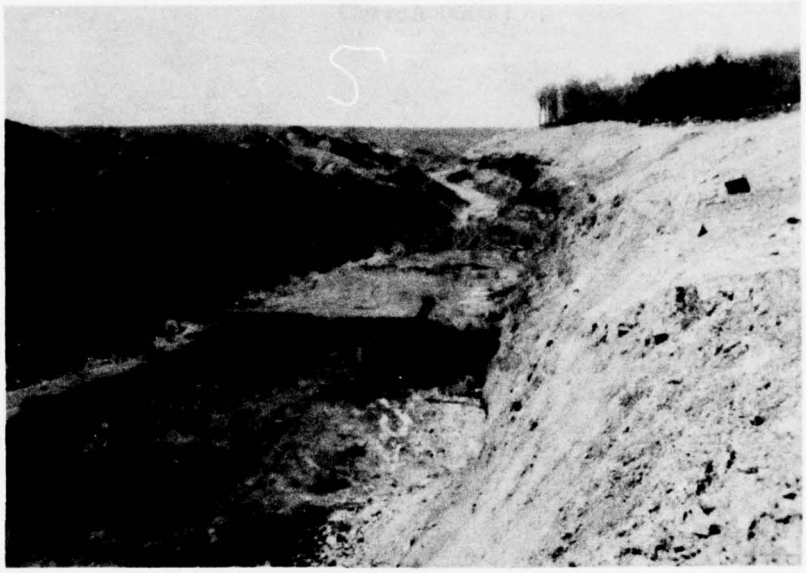
Other rapidly urbanizing areas are presently facing the same situation. Most of these are found in the rapidly expanding Boston-New York-Washington Megalopolis Area.

TABLE Q-10

EROSION DAMAGE TO URBAN LAND
NORTH ATLANTIC REGION

Subregion and Area	Urban Land Subject to Erosion			Annual Soil Loss
	Slight: Established Urban	Moderate: Recently Developed	Severe: Undergoing Construction	
	(1000 Acres)			(1000 Tons)
Subregion A				
1	33.8	.8	.4	70.0
2	92.8	.8	.4	169.2
3	95.4	.4	.2	312.0
4	85.4	.4	.2	172.0
5	124.8	.8	.4	428.4
Subtotal A	432.2	3.2	1.6	1151.6
Subregion B				
6	138.4	2.5	1.1	411.8
7	194.7	54.8	23.5	1583.4
8	143.0	80.5	34.5	1341.6
9	436.3	57.2	24.5	2232.6
10	140.0	76.3	32.7	674.8
Subtotal B	1052.4	271.3	116.3	6244.2
Subregion C				
11	129.7	1.6	.7	521.4
12	370.6	13.6	5.8	2613.0
13	485.0	44.1	18.9	1534.4
Subtotal C	985.3	59.3	25.4	4668.8
Subregion D				
14	292.7	108.7	46.6	2410.2
15	716.0	58.1	24.9	6871.4
16	192.5	7.8	3.7	714.0
Subtotal D	1201.2	174.6	75.2	9995.6
Subregion E				
17	788.3	66.3	28.4	13757.1
18	75.0	107.1	45.9	2225.3
Subtotal E	863.3	173.4	74.3	15982.4
Subregion F				
19	215.0	110.6	47.4	5039.2
20	111.9	2.9	1.2	1416.4
21	338.3	5.4	2.3	5670.9
Subtotal F	665.2	118.9	50.9	12126.5
REGION TOTAL	5199.6	800.7	343.7	50169.4

In several parts of Area 17 there are extensive coal stripping operations which have higher soil loss rates. Although the actual erosion rates are high, because of a total lack of cover, the amount of sediment which reaches a watercourse is somewhat lower than would be expected. Much of the sediment is deposited in the stripping pits or is filtered out by good vegetative cover conditions on the land adjacent to stripping spoil.



Fifty feet of overburden is being removed to expose coal seam in this strip mining operation.

A related occurrence is sand and gravel operations which are adjacent to a stream. Erosion occurs on the raw cut faces and the sediment then has direct access to the stream. Washing and screening of the sand and gravel also adds material to the stream.

Several types of erosion damage are more evident than others when actively occurring. These include streambank erosion, sheet and gully erosion in urban and highway construction areas, and shoreline erosion. Often the scattered nature of these damages and the high correction cost cause them to go untreated.

Streambank erosion exists on about 10 percent of the banks within the region. There are approximately 5,400 bank miles of major erosion. Average annual erosion damages resulting from the land loss total around $535,000. A breakdown of these figures by area is shown in Table Q-11.

Although there appears to be a large number of miles of streambank erosion, much of it is scattered throughout the various areas and is not continuous. Lateral streambank cutting is generally less than one foot per year of lower value land, resulting in only small land area losses.

TABLE Q-11

STREAMBANK EROSION PROBLEMS AND DAMAGES (6) (7)
NORTH ATLANTIC REGION

Subregion and Area	Total Channel Length (Stream Miles)	Length of Erosion (Bank Miles)	Length of Major Erosion (Bank Miles)	AVERAGE ANNUAL DAMAGE		
				Land Loss ($1000)	Sedimentation ($1000)	Other ($1000)
Subregion A						
1	5,243	121	14	3	6	1
2	6,167	167	23	6	21	1
3	4,917	175	28	7	6	1
4	2,805	98	18	5	3	4
5	4,503	157	27	7	1	1
Total A	23,635	718	110	28	37	8
Subregion B						
6	3,279	146	31	6	5	5
7	4,392	179	44	4	13	2
8	8,864	498	98	8	170	9
9	3,965	181	46	7	31	1
10	4,058	195	48	7	113	1
Total B	24,558	1,199	267	32	332	18
Subregion C						
11	7,610	830	300	125	404	267
12	12,510	930	320	113	258	287
13	940	80	60	4	5	2
Total C	21,060	1,840	680	242	667	556
Subregion D						
14	4,300	550	370	23	68	131
15	12,080	2,120	680	22	35	7
16	2,600	160	80	2	2	0
Total D	18,980	2,830	1,130	47	105	138
Subregion E						
17	24,830	5,550	1,130	37	65	3
18	5,300	310	180	4	5	0
Total E	30,130	5,860	1,310	41	70	3
Subregion F						
19	11,660	1,630	950	46	47	4
20	4,820	460	360	42	16	2
21	8,800	990	590	57	38	2
Total F	25,280	3,080	1,900	145	101	8
REGIONAL TOTALS	143,643	15,527	5,397	535	1,312	731

Shoreline erosion to some degree is occurring along much of the 8,500 miles of coastline in the NAR.(2) Approximately 934 miles are considered critical. Most of critical erosion occurs along the Atlantic Ocean shorelines of New York and New Jersey. Table Q-12 gives the areas and amounts of shoreline and critical erosion.

TABLE Q-12

SHORELINE EROSION PROBLEMS
NORTH ATLANTIC REGION

Subregion and Area	Total Shoreline	Stable	Unstable	
			Noncritical	Critical
		(Miles)		
Subregion A				
5	1900	5	1895	-
Subregion B				
6	640	2	616	22
7	10	-	9	1
9	1380	40	1186	154
10	270	5	240	25
Subregion C				
13	605	-	327	278
Subregion D				
15	299	221	48	30
16	402	179	84	139
Subregion E				
18	2099	175	1717	207
Subregion F				
19	373	128	235	10
20	342	254	56	32
21	160	78	46	36
REGION TOTAL	8480	1087	6459	934

Damages have not been estimated. Shoreline recreational opportunities are required to serve the needs of the growing population and damage to the beaches reduces the area available for ocean sports. In other areas individual homeowners are experiencing a loss of beach and gradual encroachment towards their homes.

Sediment

All subregions are considered sediment problem areas. In this appendix, sedimentation yield rates are considered to be a measure of the sediment problem. Sediment problems of various degrees exist throughout the region. See Table Q-8 .

Overland erosion is the chief sediment contributor. It is difficult to measure the quantity of sediment from sheet erosion versus channel erosion. The proximity of the sediment producing area to the water course, the type of erosion, and effects of man's activities on the erosion process are factors causing various sediment quantities and damages at different locations. Aesthetic values and diseconomies from point of origin to removal are difficult, if not impossible, to measure. Table Q-13 indicates the monetary value of damages from sheet and channel erosion.

TABLE Q-13
MONETARY DAMAGE FROM SEDIMENT
NORTH ATLANTIC REGION

Subregion	Sheet Erosion Volume (1000 cu.yd.)	Sheet Erosion Dollars ($1000)	Streambank Erosion Length (Miles)	Streambank Erosion Dollars ($1000)	Estimated Dollar Sediment Damage ($1000)
A	458	916	718	37	953
B	1126	2252	1199	332	2584
C	1052	2104	1840	667	2771
D	2287	4574	2830	105	4679
E	4891	9782	5860	70	9852
F	4202	8404	3080	101	8505
REGION TOTAL	14016	28032	15527	1312	29344

FUTURE CONDITIONS

Land use in the NAR changes rapidly. Crop and pastureland areas are decreasing and by 2020 there is expected to be less than half the present land area now in crops and pasture. Forest land areas show little change, decreasing only 4 percent by 2020. Urban land increases about 150 percent by 2020 and the Other lands almost double their present amount. These projections are based upon historical trends as shown in Appendix G, "Land Use and Management".

Projected Erosion Rates

Land use changes are reflected in the projected erosion rates shown in Table Q-14. There is a steady increase in the rate of erosion to 1980, 2000 and 2020 even though the present relationship between the amounts of land adequately treated and land needing treatment is maintained on the agricultural lands. This increase is due to the land use shift from crop and pasture to urban and other land. Urban land in the NAR is estimated to have an average erosion rate more than twice the average rate from cropland.

TABLE Q-14

COMPARISON OF FUTURE EROSION RATES ON ALL LAND WITH

PRESENT AND ACCELERATED LAND TREATMENT

NORTH ATLANTIC REGION

Subregion and Area	1980			2000			2020		
	Present Rate	Accel. L.T.	Percent Reduction	Present Rate	Accel. L.T.	Percent Reduction	Present Rate	Accel. L.T.	Percent Reduction
	Tons/Square Mile/Year								
Subregion A									
1	173	166	4.0	154	147	4.5	166	160	3.6
2	173	173	0.0	173	173	0.0	179	179	0.0
3	211	211	0.0	218	211	3.2	224	224	0.0
4	179	179	0.0	173	173	0.0	179	173	3.4
5	173	166	4.0	173	173	0.0	179	173	3.4
Subaverage A	180	178	1.1	177	174	1.7	184	181	1.6
Subregion B									
6	198	198	0.0	243	218	10.3	307	250	18.6
7	627	589	6.1	768	646	15.9	1043	781	25.1
8	461	429	6.9	512	448	12.5	614	506	17.6
9	851	806	5.3	1050	883	15.9	1402	1050	25.1
10	493	461	6.5	557	501	10.1	672	582	13.4
Subaverage B	515	485	5.8	604	522	13.6	769	609	20.8
Subregion C									
11	205	203	1.0	256	243	5.1	339	326	3.8
12	538	525	2.4	557	518	7.0	646	582	9.9
13	1254	1210	3.5	1421	1267	10.8	1504	1299	13.6
Subaverage C	439	429	2.3	482	447	7.3	568	499	12.1
Subregion D									
14	2086	1894	9.2	2547	2054	19.4	2982	2259	24.2
15	1574	1485	5.7	1696	1485	12.4	1875	1555	17.1
16	608	582	4.3	698	608	12.9	832	666	20.0
Subaverage D	1518	1423	6.3	1682	1448	13.9	1890	1535	18.8
Subregion E									
17	1510	1414	6.4	1638	1370	16.4	1926	1498	22.2
18	1709	1524	10.8	1907	1506	21.0	2227	1586	28.8
Subaverage E	1552	1438	7.3	1695	1395	17.7	1989	1517	23.7
Subregion F									
19	1664	1512	9.1	1869	1568	16.1	2246	1788	20.4
20	1165	1114	4.4	1152	1021	11.4	1261	1061	15.9
21	1670	1619	3.1	1696	1504	11.3	2157	1807	16.2
Subaverage F	1571	1472	6.3	1674	1440	14.0	2028	1658	18.2
REGION AVERAGE	959	900	6.2	1046	896	14.3	1237	998	19.3

Estimates of average erosion rates during the transition to urban use, while the soil is unprotected, are as much as 75 times greater than the rate from cropland. Therefore, urban erosion control must play an important role in water resources planning for the NAR.

Land treatment will also be important. Table Q-14 shows the estimated erosion rates for the NAR with an accelerated land treatment program on agricultural and urban lands. Conservation principles used on agricultural lands work equally as well on urban fringe lands. Even with an accelerated land treatment program the erosion rates increase in the time frames 1980, 2000, and 2020 but to a lesser degree. Table Q-6 shows the effect of land treatment on the probable soil loss. The estimated erosion rates will be reduced an average of 19.3 percent throughout the Region by 2020. The reduction rates range from 0.0 percent in Areas 2 and 3 to 28.8 percent in Area 18.

Projected Sediment Yields

Land use changes and land treatment affecting erosion rates will result in different sediment yields. Uses and maintenance of watercourses will affect erosion and sedimentation from streambanks. Without accelerated land treatment, higher sediment yields proportionate to man's increased activities can be expected.

TABLE Q-15

COMPARISON OF FUTURE SEDIMENT YIELDS WITH
PRESENT AND ACCELERATED LAND TREATMENT
NORTH ATLANTIC REGION

Subregion	1980		2000		2020	
	Present	Accelerated	Present	Accelerated	Present	Accelerated
	1000 cubic yards/year					
A	489	484	481	473	500	492
B	1337	1259	1568	1355	1996	1581
C	1047	1024	1150	1067	1355	1191
D	2383	2234	2640	2273	2967	2410
E	4954	4590	5411	4453	6349	4843
F	4464	4182	4756	4091	5762	4711
REGION TOTAL	14674	13773	16006	13712	18929	15228

Problem Areas

The projected large increase in urban land indicates a major sediment problem can be anticipated. Urban lands account for about 30 percent of the sediment from sheet erosion. This percentage will increase to 55 by 2020 with present levels of treatment.

Substantial progress has been made in combating erosion on cropland. Nearly 40 percent is adequately treated. Although cropland acreage is expected to decline, farming on it will be more intense.

About the same livestock numbers will graze on fewer pasture acres. Trampled watercourses remain a problem. Forestry protection and management programs are difficult to implement on small ownership blocks. Intensified demands for outdoor recreation could result in overused areas; overused areas are vulnerable to the erosive forces. Parks, roads and trails, utility rights of way, landfills, mining areas, rural construction sites, and lands awaiting development pose as sources of major sedimentation problems.

Increased peak runoff from expanding urban areas, changes of stream courses brought about by encroachment and obstructions, extended bankfull or fluctuating flows brought about by operation of reservoirs, and wave action by watercraft may create streambank and inland shoreline erosion problems.

Protective barrier islands and shores are subject to destruction by development. Shore ownership complicates cooperative beach and shore protection efforts. Competitive desires for the limited ocean frontage causes unwise use and development of Atlantic Ocean beach and shores. The coastline is made even more subject to erosion.

MEANS TO PROBLEM SOLUTION

Solutions to the sediment and erosion problems fall into three categories. Broad-based planning can help avoid misuse of land unsuitable for cultivation or development. Land treatment measures can be utilized to keep the soil on the land. Finally, structural measures can be used to modify conditions in cases where major damage areas exist. Combinations of these three general erosion and sedimentation control solutions are often needed and used together.

Broad-based Resource Planning

In order to effectively carry out a program of reducing erosion and sedimentation, broad-base resource plans are necessary to control growth and development in the area. Integrated land use planning must be used to prevent random and wasteful development of an area. This planning is needed on both regional and local levels. It should place emphasis on zoning and land use adjustments of high hazard areas which produce extensive sediment if not properly used.

Shifting unsuitable cropland to other uses is necessary for effective erosion and sedimentation reduction. About 9.1 percent of the 7.9 million acres not suitable for cultivation because of the erosion hazard and another 1.3 million acres suitable for only

limited cultivation because of the erosion hazard are in cropland. Converting these acreages to suitable uses should be a part of planned land use adjustments.

Resource plans need provisions to maintain, or improve, protective cover on 6.8 million acres of land with slopes over 25 percent, in steep gradient flood plains, and on streambanks and shorelines. Where exceptions must be made, strict erosion control measures need to be used. Many erosion and sedimentation problems can be avoided by preventing the clearing of good vegetative cover.

In the next half century, from 3.2 to 8.8 million acres will shift from other to urban land uses. From the standpoint of sediment control, planning is important in areas of urban development. In his article "Mopping Up on the Menace of Mud" (22) E. Keil points out seven requirements necessary for curbing erosion during construction. These requirements include:

1. "Saving natural vegetation wherever possible.
2. Avoiding unnecessary disturbance of soil.
3. Early installation of permanent storm drains and roads.
4. Planting temporary vegetation on divided soils.
5. Installing permanent vegetation speedily after construction.
6. Construction of basins to trap sediment on site.
7. Engineering to take care of marked increases in water runoff that follows development."

Applied as part of regional plans this can be an effective method of reducing erosion and sedimentation.

Within the broad-based plan, subdivision plans are needed to help determine the suitability of the site for the kind of development to be made and to help determine the adequacy of erosion control practices to be used during construction. These plans should have information on geography, soil, and control measures.

Some ordinances have provision for grading and removal of earth, time limits to establish vegetative cover, retention of natural vegetation, surface and storm drainage, utility design standards, slope limits, and erosion and sediment control measures. Ordinances dealing with erosion and sediment control enhance and implement resource planning and development in areas that are to be urbanized.(17)

Land Treatment

Land treatment generally includes management practices, vegetative and cultural practices, and mechanical practices. These are general groupings of the various measures and are designed to reduce erosion. In many cases several measures can be used in combination with one another for more effectiveness.

Management practices play an important role in the reduction of erosion and sedimentation. These include minimum tillage, timely field operations, crop residue management, adoption of deferred grazing, proper grazing use, timber stand improvement, recreation and wildlife area management and maintenance operations. All of these practices minimize the overuse of the land while at the same time improve the condition of the cover.

Vegetative and cultural practices are effective for two main reasons. They protect the soil from the impact of the raindrops and slow down runoff. The use of grasses, either by themselves or in combination with row crops, is an important erosion control device. Grass and trees are the most common vegetative controls used on nonfarm areas. Measures which can help solve part of the problem are: conservation cropping systems, cover cropping, contour farming, stripcropping, and planting of grasses, legumes, shrubs, and trees on critical areas.

Research and experience show that sheet erosion, the major contributor to erosion and sediment damage in the NAR can be reduced over 90 percent by conventional land treatment practices.(23) Results of studies made by John B. Stall indicate that by using various conservation programs, reservoir sedimentation can be reduced as much as 73 percent; suspended sediment, 93 percent; and river turbidity, 89 percent.(24) These data are confirmed in a summary made by H. O. Ogrosky regarding the influence of conservation practices on water quality.(25)

Mechnical practices are designed to retard erosion by reducing the velocity of overland flow by cutting down on the length of the slope. Included in this group are diversions and terraces, waterways and outlets, and small grade stabilization structures. These practices, when used in conjunction with the above mentioned vegetative practices, can be extremely effective in reducing erosion.

Structural Measures

Structural measures are used to control erosion and sedimentation. These structures are designed and used to protect the land from further damage. They include debris basins, channel improvement, riprapping and cribbing, groins, pilings and jetties, and large grade stabilization structures.

Because of the rapid urbanization in the NAR, special note is made of the settling basin technique which can be effectively used to trap sediment near its source. The function of the settling basin is to check the velocity of streamflow and thereby cause the deposition of the sediment load being carried by the stream. Debris basins are formed by building dams across stream channels, across channels, and flood plains, or solely on flood plains adjacent to channel diversion dams. Settling basins are usually placed a short distance above the sediment damage area.

Roadfills required for other purposes often may be utilized with settling basins at small additional cost, and it may be desirable to hold back sediment from a new reservoir while a program of erosion control on the watershed is being developed. The feasibility of settling basins should not be overlooked.

Coordination of Efforts

The magnitude of the erosion and sedimentation problems in the NAR substantiates the need for close coordination and unification of agencies and policies dealing with these problems. On the federal level, the Water Resources Council has been assigned the responsibility.

States should provide enabling legislation to allow the formation of local public districts to deal with sediment problems, either alone or in conjunction with flooding and waste removal. Several states have recognized erosion and sedimentation problems and initiated control activities. The State of Maryland has recognized sediment as a water pollutant. Steps have been taken to document, understand, and control sediment problems caused by urbanization and highway construction. Permits are issued for construction activities, and injunctive procedures are used to halt objectionable construction practices, when excessive sediment is being produced. States can also provide financial and technical assistance in dealing with sediment problems.

There is little uniformity in the present policy dealing with erosion and sediment control at the county or local level. There is enabling state legislation which provides authority for establishing conservation districts, drainage and flood control districts, and other special purpose districts. Present procedure is for the municipality or county to organize the necessary legal entity, where necessary, and then to proceed with the construction of the planned control or protective measures. In many cases, local soil and water conservation districts utilize technical assistance provided by the Soil Conservation Service and the Forest Service in the design and construction of these control measures.

General Benefits and Costs

Effects are the physical changes resulting from accelerated erosion and sedimentation or from use of solutions. Effects determine the economic, social and environmental damages or benefits. Measurement of the effects are difficult because they frequently are not obvious and become evident over long periods of time, sources are intermixed, distance from source to place of damage make cause-effect relationships unclear, and solutions or control measures often have multiple effects.

Evaluations

Evaluations are complicated by the wide variety of interests to which benefits may accrue. Benefits from onsite effects

commonly accrue to the landowner, developer or operator. Benefits from offsite effects accrue to persons other than those on whose site the conservation measure is taken. The difficulties of identification and quantification of effects to benefactors and the value placed on the effects are obstacles to acceptable justifications and allocations.

Placing monetary values on many of the adverse impacts to society and the environment are beyond reach. Disrupted ecologies, visual appearance of discolored water, turbidity, accelerated eutrophication, sedimentation pollution, scarred landscapes and other environmental quality and aesthetic aspects defy commonly used monetary evaluations.

Solutions for erosion and sedimentation controls are active and passive devices. Passive devices-preventative measures and land use adjustments - require decisions by various agencies and organizations, public and private. Direct and indirect costs for passive devices vary considerable depending upon the scope and type of device used. Active devices - land treatment and structural measures - can be more readily quantified. Table Q-16 gives cost of active devices needed to control erosion and sedimentation in the NAR.

The damages resulting from erosion and sedimentation are more costly than land treatment measures to prevent them. It costs from 25 cents to several dollars a cubic yard to remove sediment from roads, harbors, streams and reservoirs. Providing new storage capacity may cost from 10 to 30 cents a cubic yard. It is often cheaper to build new reservoirs than to dredge sediment from existing ones. The cost of holding a cubic yard of soil on the land by land treatment measures may be many times less.(20)

Land treatment measures in the NAR are responsible for the retention of an estimated 14.7 million tons of soil on 6.2 million acres of cropland each year. An estimated equivalent monetary value is $2.35 per acre per year. This value indicates the savings to farmers due only to retention of topsoil. In addition, it is estimated that 7.5 percent of the 14.7 million tons or 1.4 million cubic yards would have produced downstream sediment damages. These damages are estimated to equal 45 cents per acre of cropland. Therefore, the total annual monetary benefit due to soil conservation practices on cropland in the NAR is $2.80 per acre, based on the estimated erosion and sedimentation rates and the monetary values presented in this Appendix.

Use of control measures on urban land has just begun. Developers, first forced by ordinances to control soil erosion and sedimentation, have discovered preventative and land treatment measures result in lowered construction costs and higher priced lots. Communities are realizing a savings in capital investments and maintenance costs.

TABLE Q - 16
COST OF DEVICES
NORTH ATLANTIC REGION

Subregion and Area	Conservation Land Treatment			Streambank Erosion Control			Beach & Shoreline Protection		
	Area	Cost		Bank	Cost		Shore	Cost	
		One Time	Ave. Ann.		Ave. Ann.	One Time		Ave. Ann.	One Time
	1000 Acres	$ Million		Mile	$ Million		Mile	$ Million	
Subregion A									
1	124	8.7	1.3	14	.06	1.0	-	-	-
2	43	2.7	.4	23	.09	1.5	-	-	-
3	53	4.0	.8	28	.11	1.9	-	-	-
4	39	3.0	.5	18	.07	1.2	-	-	-
5	30	2.9	.2	27	.10	1.8	1895	206	3752
Subtotal A	289	21.3	3.2	110	.43	7.4	1895	206	3752
Subregion B									
6	231	30.0	2.7	31	.11	1.9	638	68	1238
7	563	84.1	5.7	44	.18	3.2	10	1	20
8	972	135.4	12.7	98	.31	5.5	-	-	-
9	778	119.8	7.9	46	.24	4.4	1340	130	2370
10	700	104.2	6.9	48	.05	.9	265	23	420
Subtotal B	3244	473.5	35.9	267	.89	15.9	2253	222	4048
Subregion C									
11	536	50.7	10.9	300	1.00	18.1	-	-	-
12	921	87.3	15.6	320	.82	14.8	-	-	-
13	330	44.1	3.0	60	.06	1.2	605	21	389
Subtotal C	1787	182.1	29.5	680	1.88	34.1	605	21	389
Subregion D									
14	714	106.2	7.3	370	.56	10.1	-	-	-
15	2350	210.8	29.2	680	1.11	20.1	78	6	115
16	213	30.9	2.1	80	.16	2.9	223	10	183
Subtotal D	3277	347.9	38.6	1130	1.83	33.1	301	16	298
Subregion E									
17	4192	410.9	66.6	1130	1.67	30.1	-	-	-
18	1891	228.3	22.4	180	.90	16.2	1924	46	843
Subtotal E	6083	639.2	89.0	1310	2.57	46.3	1924	46	843
Subregion F									
19	2882	306.2	52.8	950	2.07	37.2	245	6	107
20	662	66.5	13.0	360	.68	12.3	88	3	53
21	1176	130.9	22.8	590	1.05	18.9	82	7	130
Subtotal F	4720	503.6	88.6	1900	3.80	68.4	415	16	290
REGIONAL TOTAL	19400	2168	285	5397	11	205	7393	527	9620

NOTE: Price Base 1970.
Initial cost amortized at 5-1/8% project life plus Operation & Maintenance.

Management practices to improve forage production has improved protective grass cover. Sound silviculture prevents accelerated erosion. Energetic forces of the raindrop are broken by the foliage of trees, shrubs and other vegetation. Ground litter and humus absorb and hold moisture allowing it to percolate slowly through the soil profile to ground storage. The 3.5 million acres of grass and 16.3 million acres of forest on land subject to erosion prevent erosion rates from exceeding allowable soil losses. Additional measures on 43 percent would further reduce these losses.

Streambank erosion control measures are often applied to reaches of a few hundred feet in length. About 25 miles of reach have been protected with some federal assistance. Perhaps as much as another 75 miles have had some protective measures applied. Although generally not of a serious nature, there are specific cases where streambank erosion is serious and even disastrous for a particular landowner or group of landowners. Offsite effects must be included especially in environmental considerations.

Shoreline erosion control measures provide beneficial effects on beaches, recreational and resort areas, developed properties, and undeveloped island and mainland coasts. Both public and private ownerships are the beneficiaries. In addition to vegetative and structural measures installed by these beneficiaries, about 30 miles of coastline has had federally assisted structural measures installed.

An estimated 85 percent of the Region's population lives within 25 miles of the Atlantic Ocean and Bays. The trend is for even larger portions of the population to locate near the ocean. Prudent coastal resource use becomes more crucial.

Formulation toward Objective

Erosion Hazard Soils. Land capabilities are categorized into (1) unit, (2) subclass, and (3) class. The risks of soil damage or limitation in their use become progressively greater from class I to class VIII. The land capability subclass is a grouping of units having similar kinds of limitations or hazards. Subclass "e" identifies soils on which susceptibility to erosion is the dominant problem or hazard. Land uses by capability subclass "e" as shown in Table Q-17 were obtained by updated Conservation Needs Inventory (26) printout. There are 32.4 million acres subject to erosion in the NAR.

Soil used within its capability on which the conservation practices that are essential to its protection and improvement have been applied are considered adequately treated. The acres of soil subject to erosion that are adequately treated, practices, and costs are shown in Appendix G.

TABLE Q-17

USE OF SOIL WITH EROSION HAZARD 1/
NORTH ATLANTIC REGION

Subregion and Area	Crop land	Grass-land	Forest	Other Land	Urban	Total "e" Soils 1/
	1000 Acres					
Subregion A						
1	104	3	297	4	-	408
2	53	9	67	7	-	136
3	104	19	73	2	-	198
4	52	5	62	10	-	129
5	60	3	194	5	31	293
Subtotal A	373	39	693	28	31	1164
Subregion B						
6	86	14	168	50	19	337
7	73	9	65	31	17	195
8	254	103	252	59	8	676
9	41	10	73	28	16	168
10	103	34	122	56	18	333
Subtotal B	557	170	680	224	78	1709
Subregion C						
11	540	245	245	73	-	1103
12	804	333	1467	302	58	2964
13	15	2	45	20	3	85
Subtotal C	1359	580	1757	395	61	4152
Subregion D						
14	142	17	100	65	27	351
15	1206	231	846	316	10	2609
16	68	6	63	8	-	145
Subtotal D	1416	254	1009	389	37	3105
Subregion E						
17	3185	930	4002	831	-	8948
18	753	124	513	144	-	1534
Subtotal E	3938	1054	4515	975	-	10482
Subregion F						
19	1364	775	3165	376	-	5680
20	321	257	1512	103	-	2193
21	439	382	2932	130	-	3883
Subtotal F	2124	1414	7609	609	-	11756
REGION TOTAL	9767	3511	16263	2620	207	32368

1/ Erosion hazard is indicated in SCS Land Capability Subclass "e" soils subject to erosion by wind or water.

Erosion Hazard Banks and Shores. Streambanks and shorelines that are eroding are further categorized as major and critical erosion respectively. Degree of erodibility as obtained from the assessment of streambank erosion (7 & 8) and the shoreline study (2) are shown in Tables Q-11 and Q-12.

National Efficiency (NE). Planned land use is the adjustment of Class VIe cropland to pasture or forest and the preservation of Class VIe and above in pasture and forest. Accelerated land treatment shown on page Q-14 is applied to cropland subject to erosion and to all urbanizing land (land changing from other uses to urban use). Two percent by 1980 and 5 percent by each of the subsequent time frame years of the major streambank and critical shoreline would be treated.

Regional Development (RD). Planned land use is the adjustment of Class IVe and above cropland to a land use with permanent vegetative cover and the preservation of Class VIe and above pasture and forest. Adequate land treatment would be applied on crop, pasture, and other land subject to erosion, logging and skid trails in forests, and all urbanizing land. Five percent by 1980 and 10 percent by each of the subsequent time frame years of major streambank and critical shoreline would be treated.

Environmental Quality (EQ). Planned use and treatment quantities are those described under RD. Planned use and treatment will be specifically oriented toward the development of a high visual quality and enhancement of the environment. Half the streambank erosion problems would be overcome; 10 percent by 1980, another 20 percent by 2000, and the remaining 20 percent by 2020. Half the beaches would be protected by 1980, other half the beaches and 10 percent of the critical shoreline by 2000, and 20 percent of critical shoreline will be treated by 2020.

NEEDED RESEARCH

Research needs, data collection and policy for the recognition and control of erosion and sedimentation in the NAR include:

1. More water quality measuring installations and water quality records, especially sediment loads of streams, are needed. These data should be collected on a wide range of drainage areas.

2. Continuing and expanded study of the detachment and movement of soil particles by raindrop splash and flowing water, surface sealing and related phenomena that result in decreased infiltration, water intake and movement through soil during freezing and thaw periods, the role of plant cover and crop residues in reducing erosion, and the development of concepts relating erosion to topographic, climatic and

soil factors. Improved factors for use in soil loss prediction equations need to be developed.

3. More information is needed on rates of sediment deposition in reservoirs and water detention structures, on flood plains, and in harbors and estuaries.

4. Procedures must be developed for identifying critical erosion and sediment source areas and predicting yields from these areas.

5. Improved criteria are needed for the engineering design of sediment traps, debris basins, and channel stabilization structures.

6. Improved plant materials need to be developed for roadside, bank, beach stabilization and acid soil areas.

7. Erosion control practices for farm use must be developed that are compatible with modern farming methods.

8. Efficient and feasible erosion control practices must be developed for use in urban and suburban developments that are compatible with efficient construction practices.

9. Effective procedures to implement erosion control plans and practices need to be developed. Particular reference should be given to levels of government which handle land use regulations.

10. Clear policies on land use, management and use of flood plains and shorelines, and on erosion and sedimentation control need to be developed nationally and by river basins.

CONCLUSIONS

Increased populations require facilities in which to live, work, and play. The production of food and fiber and construction of required facilities will nearly double in the NAR in the next half century. Erosion and sedimentation problems will continue to increase in the NAR. The average annual rate is expected to increase from 917 to 1237 tons per square mile per year by 2020.

Land use adjustments could reduce erosion rates and sediment yields by 13 percent. Measures need to be taken to preserve protective cover on high hazard areas. Resource plans are necessary to bring about land use adjustments and keep desirable land uses.

If the conservation land treatment program is accelerated, erosion and sedimentation yields will still increase, but at a slower rate. The average annual erosion rate is expected to be

983 tons per square mile by 2020, with an accelerated land treatment program which includes treatment of urban and industrial sites as well as an increase in the acreage of agricultural land treated.

Structural measures reduce erosion and sedimentation problems at high damage areas. High costs, cost-benefit relationship, and/or limited number of onsite beneficiaries frequently make structural measure installations prohibitive.

Raising the levels (amounts) of land treatment is difficult for several reasons:

(1) Mutual interests of the individual land user and society are generally not recognized. Onsite benefits and offsite benefits are measured independently of one another. The farmer's decision is based upon increased income from the eroding land. Society's decision is based on sediment reduction in and adjacent to the streams. When mutual interests are measured together, conservation measures can often be easily justified.

(2) Interests of the individual land user and society do not always coincide. Maximum profit to the speculator that has stripped the development site causes society to suffer the sediment pollution and sedimentation. But, society doesn't pay the speculator for cleaner water resulting from conservation measures. Laws, ordinances, and regulation are needed to protect society's interest.

(3) People are unaware of the problem. The cottage owner fails to recognize eutrophication in his lake is accelerated by erosion from the distant construction site on which he works. People must be helped to perceive their environment and consequences on their welfare.

(4) People continually change the use of land. Farmlands are are becoming suburbs. Logging areas are becoming retreat camps and home sites. New conservation measures are required on new land uses. These measures are not always immediately applied.

(5) Resource user may fail to apply practices because of short or uncertain land tenure. The farmer is not inclined to maintain land productivity knowing a new highway and industrial park are to be constructed within the next few years.

(6) People sometimes lack the knowledge to apply conservation measures. Technical assistance needs to be made available.

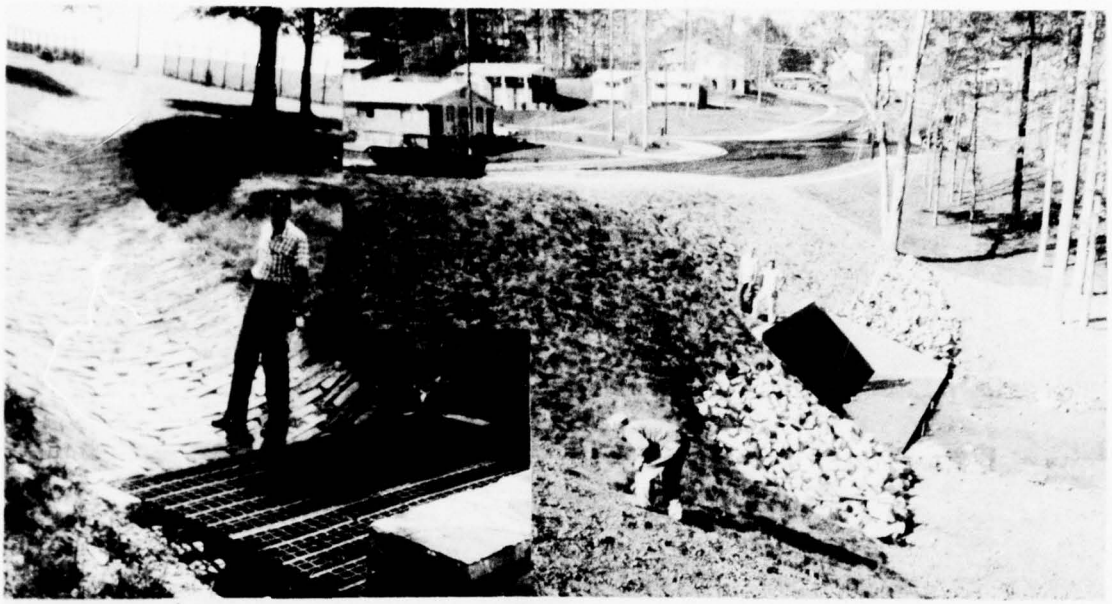
(7) People sometimes lack financial resources to make sound investments. Cost-sharing and credit need to be made available.

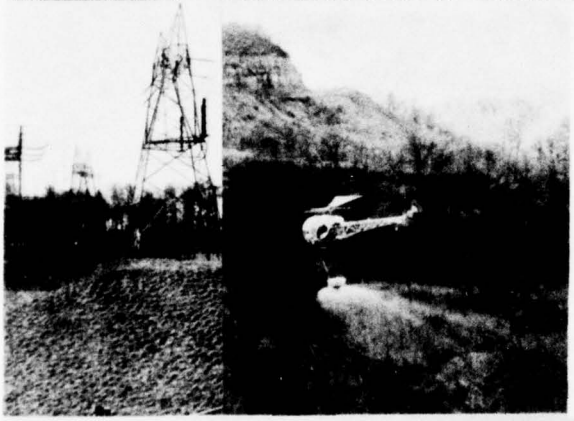
Erosion control and sediment reduction need to be viewed as an integral part of a comprehensive conservation effort. Land required for production of food and fiber are based upon a continuing high rate of adoption of technology and the proper use of land. Efficient and attractive place to work and live require discrete land use adjustments and conservation measures. Landscapes need to provide pleasing visual appearances. Unique areas and delicate ecological systems must be protected. Importance of the conservation effect upon the welfare needs to be understood.

Future comprehensive river basin studies should include more detailed erosion and sedimentation studies in Subregions D, E, and F. These Subregions are major contributors to the erosion and sedimentation problems of the Region. Areas 15, 17, 18, 19, and 21 are the more serious sedimentation problem areas. These Areas account for approximately 70 percent of the total annual sediment yield in the NAR.

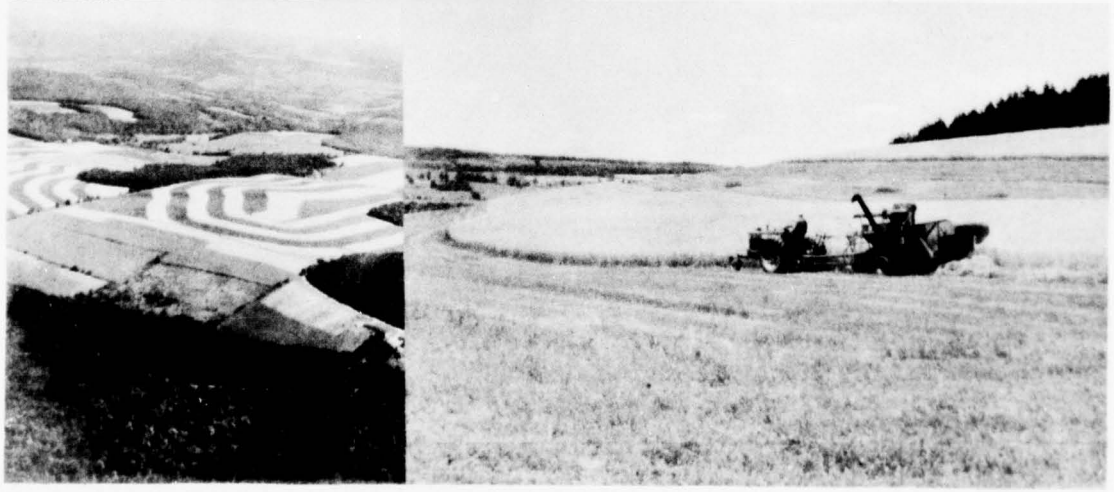
Man can control the accelerated erosion caused by his activities. He has the technical ability. But erosion rates are increasing! Forty years ago, conservation efforts proved effective; the individual landowner was the chief beneficiary. Now, a complex society desirous of a high quality environment would be the chief beneficiary. Communities, regions, states, and a nation need to set objectives as related to natural resources. Clearly defined policy statements, legislation, regulation, programs, and procedures are needed to implement technical solutions for reaching objectives. People need to take decisive action to control erosion and reduce sediment.

Erosion from urban and agricultural land scars the landscape and the resulting sediment fills culverts and chokes streams.





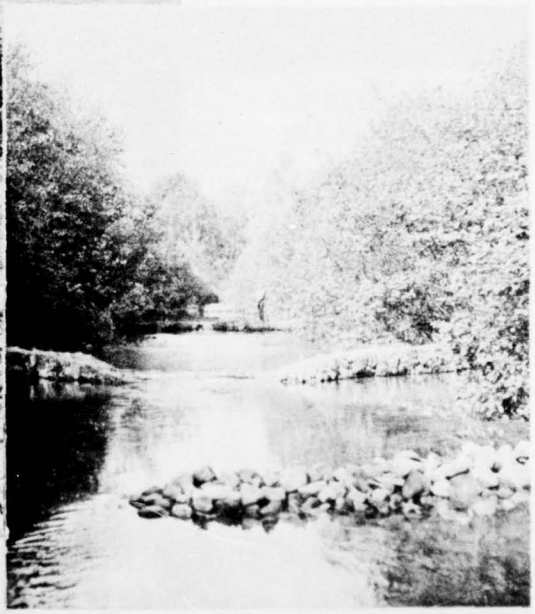
Erosion is controlled in urban and rural areas by vegetative practices, structural measures and good land management.

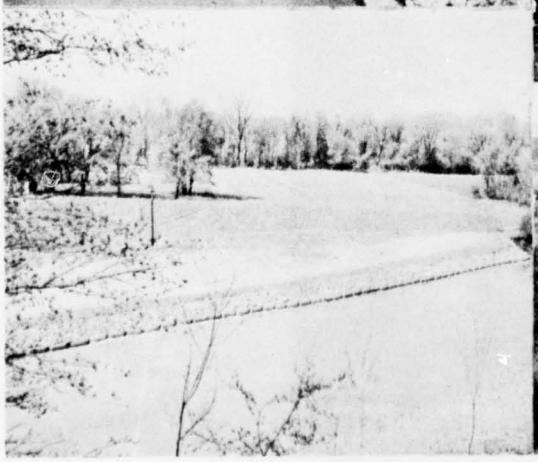


Stream undercuts the bank on the outside curve causing the bank to slough and slump into the river.

Rampaging stream waters have washed out bridge. Necessity of rerouting traffic is an indirect damage.

Active devices used for streambank erosion control include grade stabilization structures, paved channel, gabions, riprapped banks, and vegetated banks.

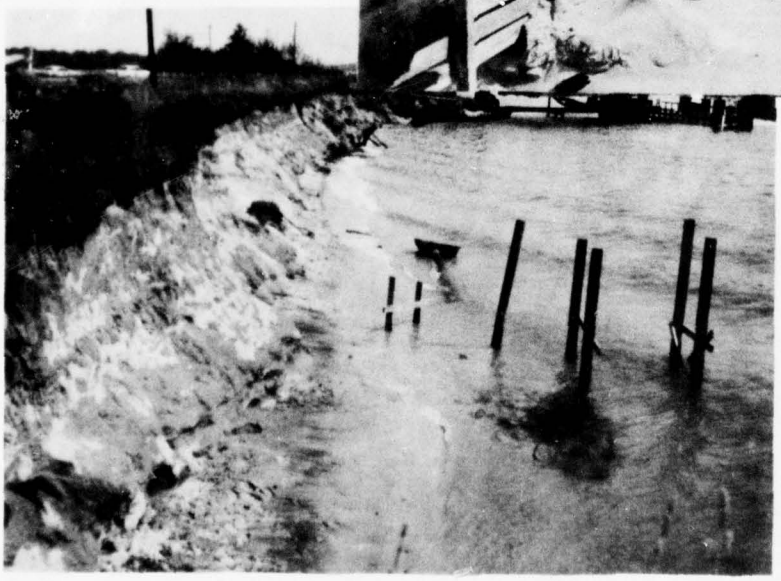




Storm and high tide damages ocean front properties.

Sand and salt water has killed vegetation.

Erosion is caused by tidal water fluctuation and wave action from passing boats.



Beachgrass has stabilized sand dune and protects beach front property

Groins protect a beach area

Sand buildup by use of jetties causes shoreline to accrete instead of recede.

Stone Valley is a neat little area of homes and farms.
Steep slopes are in trees. Farmland is covered with contour strips.
Water soaks into the ground instead of rushing downhill carrying
sediment into the Susquehanna River.

IV - SUBREGIONAL SUMMARIES

SUBREGION A (Areas 1, 2, 3, 4, and 5)

Land Erosion

Existing Conditions

This northernmost Subregion of the NAR has the lowest erosion rates of the entire Region, averaging only 170 tons per square mile per year. Annual rates from individual Areas range from 154 tons per square mile in Area 4 to 186 tons per square mile in Area 3.

The soils of the Subregion have an average erodibility factor of 0.25 which is equal to the average for the Region. The topography is gentle to steep. The maximum 2-year, 30-minute rainfall is the lowest in the Region, averaging 0.7 inches. The greatest influences on the low erosion rates in the Subregion are the land use and cover conditions. Forest lands comprise 89.5 percent of the total land area. The land use next in order of magnitude is cropland which comprises 5.7 percent of the total land area. Generally, the cropland in Subregion A contributes little to the total erosion figure. Crop rotations consisting of several years of hay provide excellent cover conditions. This is true throughout the Subregion with the exception of Area 1. The cropland in Area 1 is used more intensively and has a composite crop rotation that consists of two years of row crops, a year of small grain, and two years of hay. This type of rotation results in ten times the erosion caused by the rotations in the remainder of the Areas. Pasture, urban and other have a combined total of only 4.8 percent of the total land area in the Subregion. Therefore, erosion from these land uses has little effect on the average erosion rates.

Subregion A also has the lowest sedimentation rates in the Region. The annual sediment yield ranges from 12 to 14 tons from each square mile of land area within the Subregion.

Annual erosion and sedimentation damages are estimated to be $531,000 and $916,000 respectively. About 70 percent of the erosion damage occurs in Area 1. Areas 1 and 2 each contribute close to 25 percent of the sediment damages.

Predicted Rates

The projected land use patterns will not change as rapidly in Subregion A as they are changing in the other Subregions. Consequently, the erosion rates are more stable. The only noticeable change is from crop and pasture to other land use. The fact that forest land remains the major land use, almost 90 percent of the total land area, is the main reason for the slight increases in the erosion rates by 2020. It follows that accelerated land treatment will have little or no effect on the erosion rates for the Areas in this Subregion.

Sedimentation rates will change very little. The average annual sediment yield is expected to be 13 tons per square mile of land area in Subregion A by 2020.

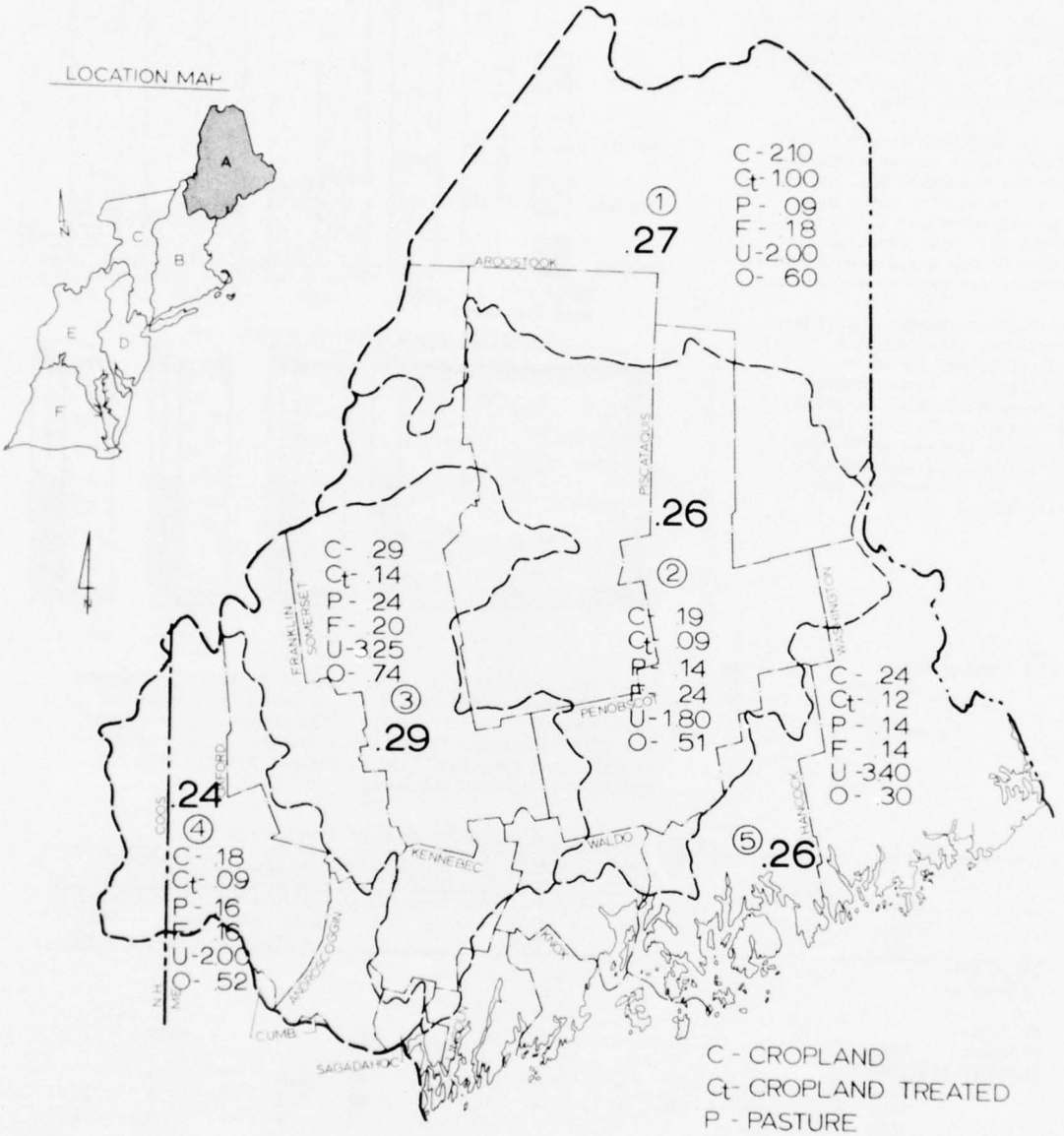
Problem Areas

Generally, none of the Areas in Subregion A are considered erosion problem areas because the erosion rates from the cropland are well below the allowable soil loss. Sedimentation problems are also relatively minor. The entire Subregion contributes only 3 percent of the total volume of sediment from the Region.

Streambank and Shoreline Erosion

Of the approximately 23,635 miles of stream channel in this subregion, 718 miles have eroding banks. However, only 110 bank miles are considered to have major erosion problems. Total average annual damage from land loss, sedimentation, and other sources is $73,000 which is the lowest of the subregions in the NAR.

Area 5 is the only area in this subregion which contains coastal shoreline. Of the 1,900 miles of shoreline, 5 miles are considered stable and the remaining 1,895 miles have noncritical erosion. This is primarily due to the rocky nature of the coastline which retards erosion.



SUB-REGION A
AREAS ① - ⑤

PROBABLE SOIL LOSS IN TONS PER ACRE PER YEAR
(PRESENT CONDITIONS)

10 5 0 10 20 30 40 Miles
SCALE

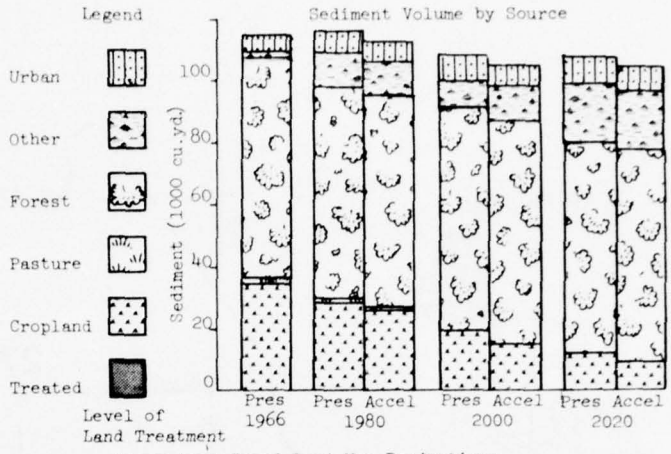
FIGURE Q-7

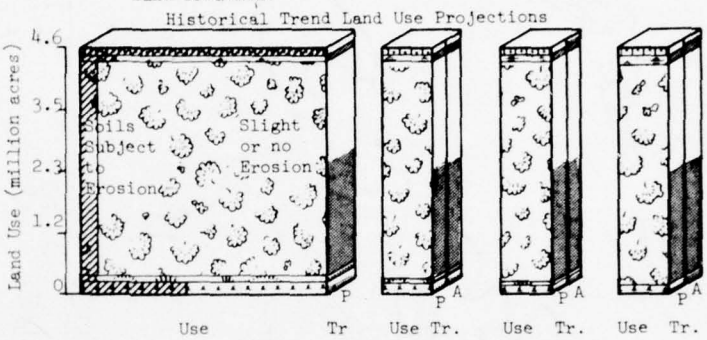
SUBREGION A - AREA 1

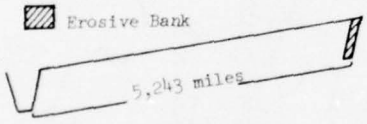
Erosion is the dominant soil hazard on 9% of the Area's 4.6 million acres. An estimated 18% of the sediment comes from these 408,000 acres. The 40% row crops of the 240,000 acres of cropland, 400 acres of construction areas, and 100 acres of critical erosion areas are particularly vulnerable to erosion.

Land use adjustments are needed on 4,000 acres (rates exceeding twice the allowable soil loss). Present protective cover needs to be maintained on 1,000 acres to prevent excessive erosion. Another 86,000 acres need adequate treatment for erosion control.

Conservation treatment includes: diversions, stripcropping, cover cropping, roadside stabilization, establishment and re-establishment of grass, trees, and shrubs, settling and debris basins, grade control structures, and wildlife habitat and development and preservation.







Major bank erosion exists on 14 miles of the 5.2 thousand miles of streams and rivers in the Area. An estimated 10,800 acres of buffer strips would prevent bank overfall and filter sediment. Streambank erosion control includes clearing and snagging, riprap, channel lining, drop spillways and vegetated banks.

EROSION CONTROL DEMANDS USED IN PLAN FORMULATION

Objective	Time Frame Year	Planned Land Use: Pre-served	Planned Land Use: Adjust	Land Treatment for Erosion Control: Conservation Land Treatment: Crop-land	Past-ure	Forest	Other	Urban	Total	Installation: Initial Cost $ Million	Ave* Ann.	Streambank Erosion Control: Treat-ment Mile	Initial Cost $ Mil.
		1000 Ac.		1000 Ac.									
Adequately treated or not feasible to treat	1966	3		20	1	163	4	35	223			5122	**
NATIONAL EFFICIENCY													
	1980	1	<1	42	-	-	-	1	43	2.8	.5	-	
	2000	-	-	29	-	-	-	3	32	2.3	.3	1	.1
	2020	-	-	4	-	-	-	4	8	.9	<.1	1	.1
REGIONAL DEVELOPMENT													
	1980	1	4	51	1	-	6	2	60	4.0	.7	1	.1
	2000	-	-	35	-	-	6	4	45	3.1	.5	1	.1
	2020	-	-	4	-	1	9	5	19	1.6	.1	1	.1
ENVIRONMENTAL QUALITY													
	1980	1	4	51	1	-	6	2	60	4.0	.7	1	.1
	2000	-	-	35	-	1	6	4	46	3.2	.5	3	.2
	2020	-	-	4	-	-	9	5	18	1.5	.1	3	.2

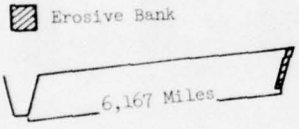
NOTE: The values shown in the table are incremental. Price Base 1970.
* Initial cost amortized at 5-1/8% project life plus Operation & Maintenance.
** Negligible erosion or stable.

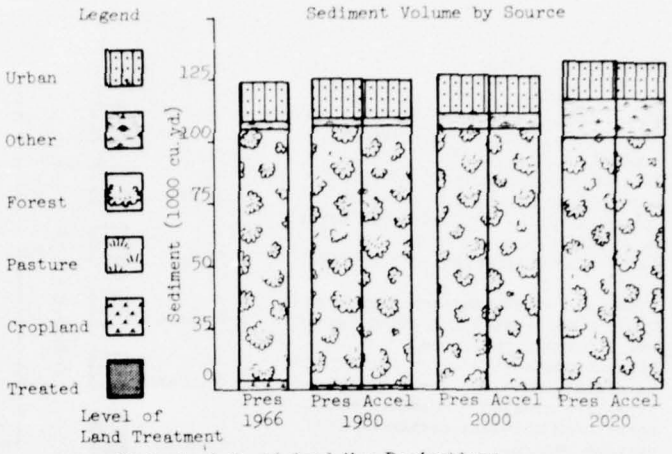
SUBREGION A - AREA 2

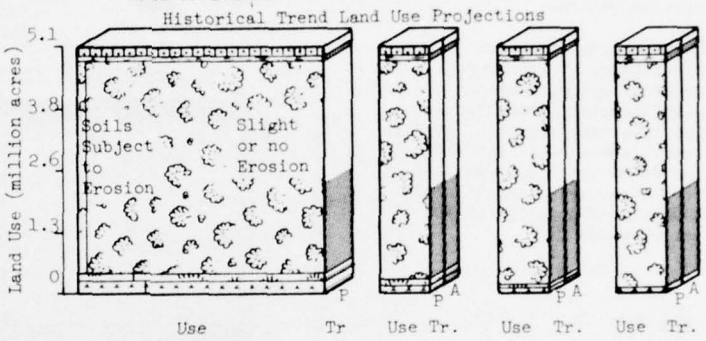
Erosion is the dominant soil hazard on 3% of the Area's 5.1 million acres. An estimated 10% of the sediment comes from these 136,000 acres. The 10% row crops of the 196,000 acres of cropland, and 400 acres of construction areas, are particularly vulnerable to erosion.

Land use adjustments are needed on 2,000 acres (rates exceeding twice the allowable soil loss). Present protective cover needs to be maintained on 1,000 acres to prevent excessive erosion. Another 53,000 acres need adequate treatment for erosion control.

Conservation treatments includes: diversions, stripcropping, cover cropping, roadside stabilization, establishment and re-establishment of grass, trees, and shrubs, settling and debris basins, grade control structures, and wildlife habitat and development and preservation.







Major bank erosion exists on 23 miles of the 6.2 thousand miles of streams and rivers in the Area. An estimated 12,700 acres of buffer strips would prevent bank overfall and filter sediment. Streambank erosion control includes clearing and snagging, riprap, channel lining, drop spillways and vegetated banks.

EROSION CONTROL DEMANDS USED IN PLAN FORMULATION

Objective	Time Frame Year	Planned Land Use: Pre-served 1000 Ac.	Planned Land Use: Adjust 1000 Ac.	Land Treatment for Erosion Control: Conservation Land Treatment: Crop-land 1000 Ac.	Past-ure	Forest	Other	Urban	Total	Installation Cost $ Million	Ave* Ann.	Streambank Erosion Control: Treat-ment Mile	Initial Cost $ Mil.
Adequately treated or not feasible to treat	1966	193		10	2	28	7	94	141			6000	**
NATIONAL EFFICIENCY	1980	1	<1	7	-	-	-	1	8	.6	.1	-	
	2000	-	-	3	-	-	-	-	3	.2	<.1	1	.1
	2020	-	-	-	-	-	-	-	-	-	-	1	.1
REGIONAL DEVELOPMENT	1980	1	2	8	1	-	10	2	21	1.5	.2	1	.1
	2000	-	-	4	-	-	10	-	14	.8	.1	2	.1
	2020	-	-	-	-	-	8	-	8	.4	.1	2	.1
ENVIRONMENTAL QUALITY	1980	1	2	8	1	-	10	2	21	1.5	.2	2	.1
	2000	-	-	4	-	-	10	-	14	.8	.1	5	.3
	2020	-	-	-	-	-	8	-	8	.4	.1	5	.3

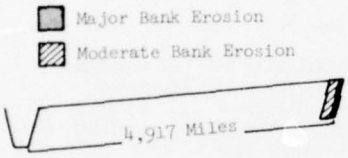
NOTE: The values shown in the table are incremental. Price Base 1970.
* Initial cost amortized at 5-1/8% project life plus Operation & Maintenance.
** Negligible erosion or stable.

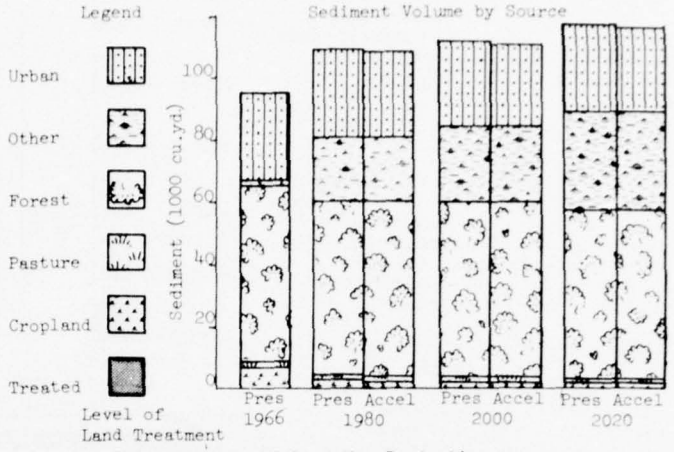
SUBREGION A - AREA 3

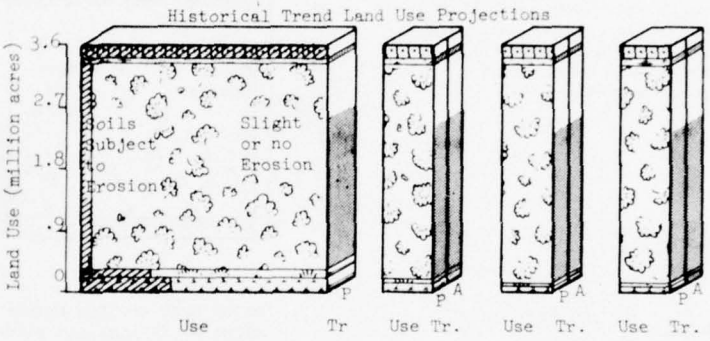
Erosion is the dominant soil hazard on 6% of the Area's 3.6 million acres. An estimated 9% of the sediment comes from these 198,000 acres. The 10% row crops of the 287,000 acres of cropland, 200 acres of construction areas, and 3,600 acres of critical erosion areas are particularly vulnerable to erosion.

Land use adjustments are needed on 6,000 acres (rates exceeding twice the allowable soil loss). Present protective cover needs to be maintained on 4,000 acres to prevent excessive erosion. Another 98,000 acres need adequate treatment for erosion control.

Conservation treatment includes: diversions, stripcropping, cover cropping, roadside stabilization, establishment and re-establishment of grass, trees, and shrubs, settling and debris basins, grade control structures, and wildlife habitat and development and preservation.







Major bank erosion exists on 28 miles of the 4.9 thousand miles of streams and rivers in the Area. An estimated 10,200 acres of buffer strips would prevent bank overfall and filter sediment. Streambank erosion control includes clearing and snagging, riprap, channel lining, drop spillways and vegetated banks.

EROSION CONTROL DEMANDS USED IN PLAN FORMULATION

Objective	Time Frame Year	Planned Land Use Pre-served: 1000 Ac.	Planned Land Use Adjust: 1000 Ac.	Land Treatment for Erosion Control — Conservation Land Treatment Crop-land: 1000 Ac.	Past-ure: 1000 Ac.	Forest: 1000 Ac.	Other: 1000 Ac.	Urban: 1000 Ac.	Total: 1000 Ac.	Installation Initial Cost $ Million	Installation Ave* Ann. $ Million	Streambank Erosion Control Treat-ment Mile	Streambank Erosion Control Initial Cost $ Mil.
Adequately treated or not feasible to treat	1966	10		21	4	53	2	96	176			4742	**
NATIONAL EFFICIENCY	1980	4	1	13	-	-	-	-	13	.8	.1	1	.1
	2000	-	-	7	-	-	-	-	7	.4	.1	1	.1
	2020	-	-	1	-	-	-	-	1	.1	<.1	1	.1
REGIONAL DEVELOPMENT	1980	4	6	17	5	-	6	1	29	2.4	.5	1	.1
	2000	-	-	9	3	-	6	-	18	1.3	.3	3	.2
	2020	-	-	1	-	-	5	-	6	.3	<.1	3	.2
ENVIRONMENTAL QUALITY	1980	4	6	17	5	-	6	1	29	2.4	.5	3	.2
	2000	-	-	9	3	-	6	-	18	1.3	.3	6	.4
	2020	-	-	1	-	-	5	-	6	.3	<.1	6	.4

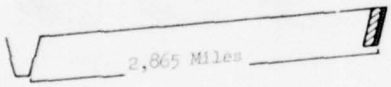
NOTE: The values shown in the table are incremental. Price Base 1970.
* Initial cost amortized at 5-1/8% project life plus Operation & Maintenance.
** Negligible erosion or stable.

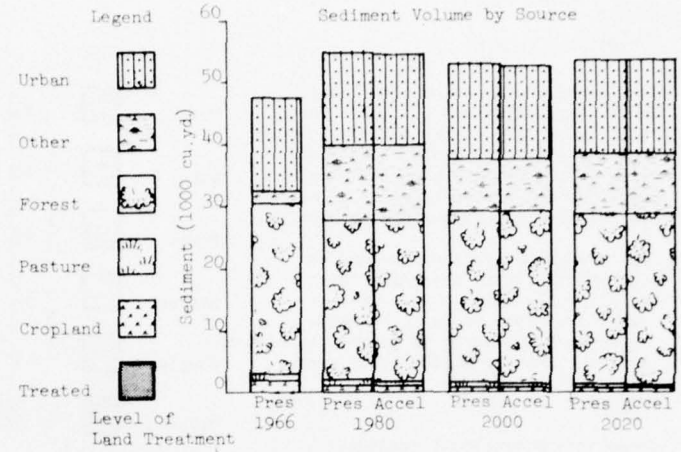
SUBREGION A - AREA 4

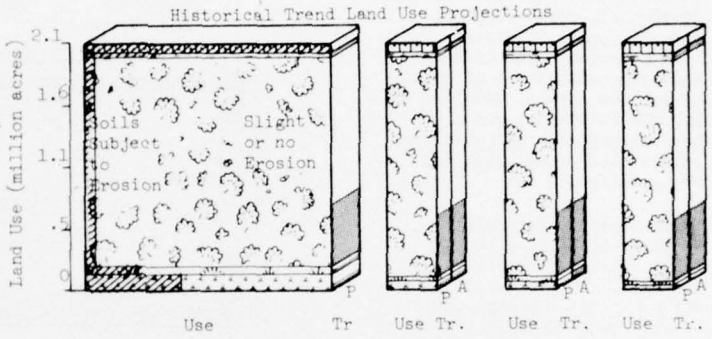
Erosion is the dominant soil hazard on 6% of the Area's 2.1 million acres. An estimated 11% of the sediment comes from these 129,000 acres. The 10% row crops of the 132,000 acres of cropland, and 200 acres of construction areas are particularly vulnerable to erosion.

Land use adjustments are needed on 2,000 acres (rates exceeding twice the allowable soil loss). Present protective cover needs to be maintained on 1,000 acres to prevent excessive erosion. Another 47,000 acres need adequate treatment for erosion control.

Conservation treatment includes: diversions, stripcropping, cover cropping, roadside stabilization, establishment and re-establishment of grass, trees, and shrubs, settling and debris basins, grade control structures, and wildlife habitat and development and preservation.







Major bank erosion exists on 18 miles of the 2.8 thousand miles of streams and rivers in the Area. An estimated 5,800 acres of buffer strips would prevent bank overfall and filter sediment. Streambank erosion control includes clearing and snagging, riprap, channel lining, drop spillways and vegetated banks.

EROSION CONTROL DEMANDS USED IN PLAN FORMULATION

Objective	Time Frame Year	Planned Land Use Pre-served	Planned Land Use Adjust	Land Treatment for Erosion Control: Conservation Land Treatment Crop-land	Past-ure	Forest	Other	Urban	Total	Installation Cost Initial $ Million	Installation Cost Ave* Ann.	Streambank Erosion Control Treat-ment Mile	Streambank Erosion Control Initial Cost $ Mil.
		1000 Ac.		1000 Ac.									
Adequately treated or not feasible to treat	1966	59		9	1	18	10	86	124			2707 **	
NATIONAL EFFICIENCY													
	1980	1	-	9	-	-	-	-	9	.6	.1	-	-
	2000	-	-	5	-	-	-	1	6	.5	.1	1	.1
	2020	-	-	1	-	-	-	-	1	.1	<.1	1	.1
REGIONAL DEVELOPMENT													
	1980	1	2	12	2	-	2	1	17	1.4	.2	1	.1
	2000	-	-	6	1	-	6	2	15	1.2	.2	2	.1
	2020	-	-	1	-	-	6	-	7	.4	.1	2	.1
ENVIRONMENTAL QUALITY													
	1980	1	2	12	2	-	2	1	17	1.4	.2	2	.1
	2000	-	-	6	1	-	6	2	15	1.2	.2	4	.3
	2020	-	-	1	-	-	6	-	7	.4	.1	4	.3

NOTE: The values shown in the table are incremental. Price Base 1970.
* Initial cost amortized at 5-1/8% project life plus Operation & Maintenance.
** Negligible erosion or stable.

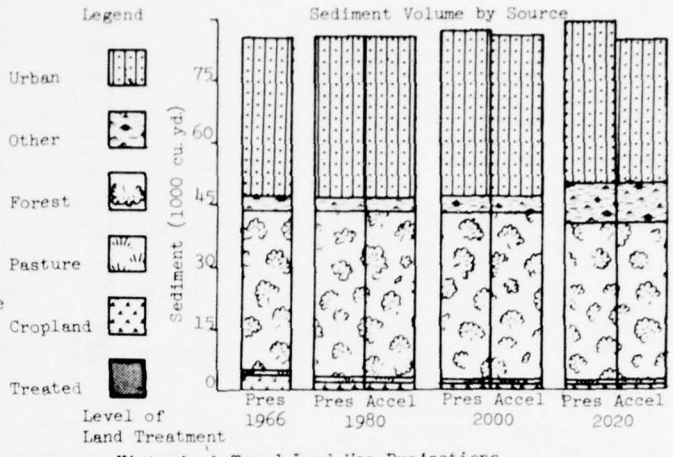
SUBREGION A - AREA 5

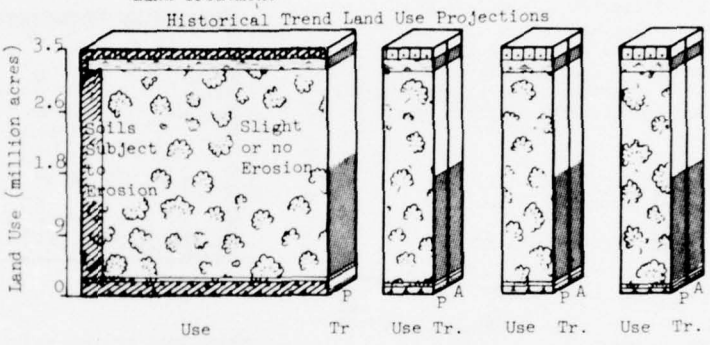
Erosion is the dominant soil hazard on 8% of the Area's 3.5 million acres. An estimated 27% of the sediment comes from these 293,000 acres. The 10% row crops of the 215,000 acres of cropland, and 400 acres of construction areas are particularly vulnerable to erosion.

Land use adjustments are needed on 7,000 acres (rates exceeding twice the allowable soil loss). Present protective cover needs to be maintained on 5,000 acres to prevent excessive erosion. Another 51,000 acres need adequate treatment for erosion control.

Conservation treatment includes: diversions, stripcropping, cover cropping, roadside stabilization, establishment and re-establishment of grass, trees, and shrubs, settling and debris basins, grade control structures, and wildlife habitat and development and preservation.

Major bank erosion exists on 27 miles of the 4.5 thousand miles of streams and rivers in the Area. An estimated 9,400 acres of buffer strips would prevent bank overfall and filter sediment. Streambank erosion control includes clearing and snagging, riprap, channel lining, drop spillways and vegetated banks.





None of the 1900 mile shorefront is critically unstable due to the rocky and massive ledge geological structure. A few small beach areas need protection using sand fill and revetments.

EROSION CONTROL DEMANDS USED IN PLAN FORMULATION

Objective	Time Frame: Year	Planned Land Use: Preserved: 1000 Ac.	Planned Land Use: Adjust: 1000 Ac.	Land Treatment for Erosion Control — Conservation Land Treatment: Cropland: 1000 Ac.	Past-ure: 1000 Ac.	Forest: 1000 Ac.	Other: 1000 Ac.	Urban: 1000 Ac.	Total: 1000 Ac.	Installation Cost: $ Million	Ave. Ann.: $ Million	Streambank Erosion Control: Treatment: Mile	Streambank Erosion Control: Initial Cost: $ Mil.	Shoreline Protection: Treatment: Mile	Shoreline Protection: Initial Cost: $ Mil.
Adequately treated or not feasible to treat	1966	62		11	1	98	5	126	241			4346	**	5	**
NATIONAL EFFICIENCY	1980	5	1	8	-	-	-	1	9	.7	.1	1	.1	-	
	2000	-	-	6	-	-	-	3	9	.9	.1	1	.1	-	
	2020	-	-	1	-	-	-	2	3	.4	<.1	1	.1	-	
REGIONAL DEVELOPMENT	1980	5	7	9	1	-	1	2	13	1.1	.1	1	.1	-	
	2000	-	-	6	1	-	1	4	12	1.2	.1	3	.2	-	
	2020	-	-	1	-	-	1	3	5	.6	<.1	3	.2	-	
ENVIRONMENTAL QUALITY	1980	5	7	9	1	-	1	2	13	1.1	.1	3	.2	23	45.5
	2000	-	-	6	1	-	1	4	12	1.2	.1	5	.3	22	43.6
	2020	-	-	1	-	-	1	3	5	.6	<.1	5	.3	-	

NOTE: The values shown in the table are incremental. Price Base 1970.
* Initial cost amortized at 5-1/8% project life plus Operation & Maintenance.
** Negligible erosion or stable.

SUBREGION B (Areas 6, 7, 8, 9, and 10)

Land Erosion

Existing Conditions

The average annual gross erosion rate for this Subregion is 437 tons per square mile. Area 9 has the highest annual rate, 762 tons per square mile. The lowest rate, 192 tons per square mile per year, is found in Area 6.

The soils in Subregion B are generally less erodible than in the other Subregions. The average soil erodibility factor is 0.17. The topography is gentle to steep but generally averages 3 to 8 percent higher than Subregion A. The maximum 2-year, 30-minute rainfall ranges from 0.7 inches in the extreme northern portion of the Subregion to 1.1 inches in the southern portion and averages 0.9 inches. Subregion B contains a high percentage of forest land, about 74.6 percent. Several large metropolitan areas result in urban lands being the second largest land use at 8.0 percent. Next is cropland, 7.4 percent; other, 6.4 percent; and pasture 3.6 percent. Crop rotations are generally more intensive in Subregion B than they are in Subregion A. A composite rotation in Area 9 is three years of row crops, probably corn silage or potatoes, followed by seven years of hay.

Average annual sedimentation rates vary from 14 to 57 tons per square mile. The average for the Subregion is estimated to be 32 tons per square mile annually.

Annual erosion damages are estimated to be $1,380,000 and sediment damages $2,250,000. Area 8 accounts for about 62 percent of the total erosion damage or nearly $856,000. Most of the remaining erosion damage occurs in Area 9, $285,000 and Area 10, $204,000. Area 8 also suffers the greatest amount of sediment damage.

Predicted Rates

Subregion B is undergoing rapid land use changes. Forest lands and other lands are expected to remain relatively stable. Cropland, pasture, and urban lands will experience major changes. Cropland will decrease from 7.4 to 1.0 percent of the total land area, and pasture will decrease from 3.6 to 0.5 percent of the total land area by 2020. Conversely, urban land will increase from 8.0 to 22.1 percent by 2020. This substantial increase in urban land use is largely responsible for the increase in the average annual erosion rate from 437 tons per square mile to 769 tons per square mile.

An accelerated land treatment program would have a noticeable effect on the erosion rates in this Subregion. The annual erosion rate in 2020, with accelerated land treatment, is expected to be

609 tons per square mile. This is a reduction of 20.8 percent. The erosion reduction due to accelerated land treatment for 1980 and 2000 will be 5.6 and 13.4 percent.

Average annual sedimentation rates for 1980, 2000, and 2020 are expected to be 39, 45, and 58 tons per square mile of land area. Area 9 has the highest individual sedimentation rate yielding 105 tons per square mile per year, on the average, by 2020.

Problem Areas

None of the Areas in Subregion B are considered erosion problem areas in this Appendix. Area 9, however, does have a relatively high rate of erosion from its cropland. The cropland erosion rate is 2.57 tons per acre per year, very close to the allowable of 3.0 tons.

Subregion B contributes approximately 8 percent of the total volume of sediment from the Region. Area 8 yields the largest individual volume of 389,000 cubic yards annually.

Streambank and Shoreline Erosion

This subregion has 24,558 miles of stream channel, of which 267 bank miles are experiencing major erosion problems. Damages total $382,000 annually and are mainly from downstream sedimentation.

All of the areas in this subregion touch the coastline, with Area 8 having so little that it is not counted. The 2,300 miles of shoreline have only 47 miles which are stable. Of the remaining 2,253 miles, 202 miles are considered critical and need treatment.

SUB-REGION B

AREAS ⑥ - ⑩

PROBABLE SOIL LOSS IN TONS PER ACRE PER YEAR

(PRESENT CONDITIONS)

FIGURE Q-8

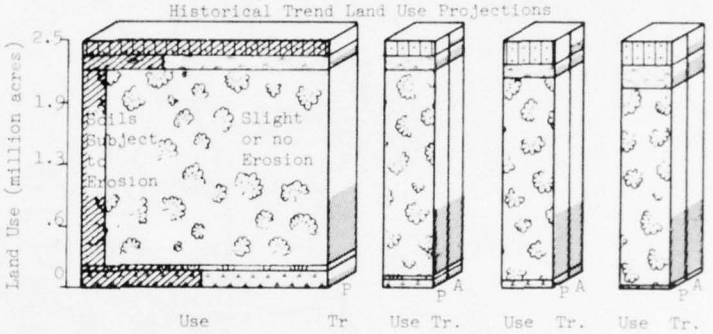
SUBREGION B - AREA 6

Erosion is the dominant soil hazard on 14% of the Area's 2.5 million acres. An estimated 39% of the sediment comes from these 337,000 acres. The 10% row crops of the 170,000 acres of cropland, 1,000 acres of construction areas and 1,400 acres of critical erosion areas are particularly vulnerable to erosion.

Land use adjustments are needed on 6,000 acres (rates exceeding twice the allowable soil loss). Present protective cover needs to be maintained on 7,000 acres to prevent excessive erosion. Another 98,000 acres need adequate treatment for erosion control.

Conservation treatment includes: diversion, stripcropping, cover cropping, roadside stabilization, establishment and re-establishment of grass, trees, and shrubs, settling and debris basins, grade control structures, and wildlife habitat and development and preservation.

Major bank erosion exists on 31 miles of the 3.3 thousand miles of streams and rivers in the Area. An estimated 6,900 acres of buffer strips would prevent bank overfall and filter sediment. Streambank erosion control includes clearing and snagging, riprap, channel lining, drop spillways and vegetated banks.



Sandy beach and dune areas are interspersed with rocky ledge outcrops on the 640 mile coastline. Of the 638 miles unstable shoreline, 22 are classified as critical. Shoreline protection includes sand fill and revetments.

EROSION CONTROL DEMANDS USED IN PLAN FORMULATION

Objective	Time Frame Year	Planned Land Use: Pre-served	Planned Land Use: Adjust	Conservation Land Treatment: Crop-land	Conservation Land Treatment: Past-ure	Conservation Land Treatment: Forest	Conservation Land Treatment: Other	Conservation Land Treatment: Urban	Conservation Land Treatment: Total	Installation Cost $ Million	Installation Ave* Ann.	Streambank Erosion Control: Treat-ment Mile	Streambank Erosion Control: Initial Cost $ Mil.	Shoreline Protection: Treat-ment Mile	Shoreline Protection: Initial Cost $ Mil.
		1000 Ac.		1000 Ac.											
Adequately treated or not feasible to treat	1966	212		21	3	54	13	142	233			3133		2	
NATIONAL EFFICIENCY															
	1980	7	2	17	-	-	-	2	19	.7	.2	1	.1	-	
	2000	-	-	8	-	-	-	42	50	7.1	.5	2	.1	1	1.9
	2020	-	-	1	-	-	-	62	63	10.0	.6	2	.1	1	1.9
REGIONAL DEVELOPMENT															
	1980	7	6	21	5	-	15	6	47	4.3	.7	2	.1	1	1.9
	2000	-	-	10	3	1	19	52	85	11.2	.9	3	.2	2	3.8
	2020	-	-	1	2	2	17	77	99	14.5	1.1	3	.2	2	3.8
ENVIRONMENTAL QUALITY															
	1980	7	6	21	5	1	15	6	48	4.4	.7	3	.2	20	38.8
	2000	-	-	10	3	2	19	52	86	11.3	.9	6	.4	22	42.7
	2020	-	-	1	2	-	17	77	97	14.3	1.1	6	.4	4	7.8

NOTE: The values shown in the table are incremental. Price Base 1970.
* Initial cost amortized at 5-1/8% project life plus Operation & Maintenance.
** Negligible erosion or stable.

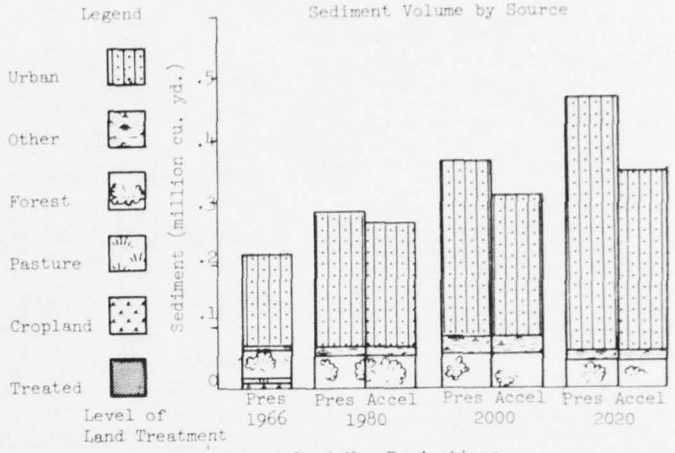
SUBREGION B - AREA 7

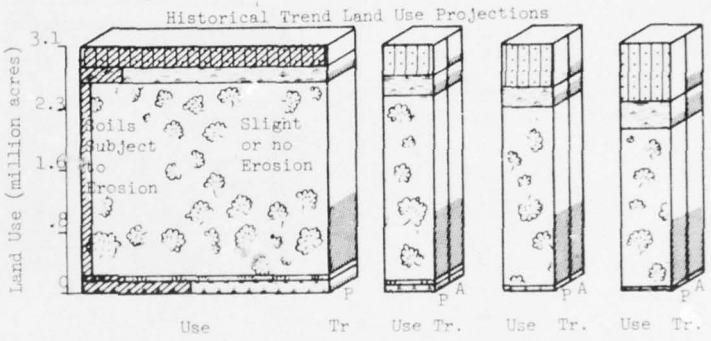
Erosion is the dominant soil hazard on 6% of the Area's 3.1 million acres. An estimated 22% of the sediment comes from these 195,000 acres. The 10% row crops of the 168,000 acres of cropland, 23,000 acres of construction areas, and 200 acres of critical erosion areas are particularly vulnerable to erosion.

Land use adjustments are needed on 5,000 acres (rates exceeding twice the allowable soil loss). Present protective cover needs to be maintained on 5,000 acres to prevent excessive erosion. Another 85,000 acres need adequate treatment for erosion control.

Conservation treatment includes: diversion, stripcropping, cover cropping, roadside stabilization, establishment and re-establishment of grass, trees, and shrubs, settling and debris basins, grade control structures, and wildlife habitat and development and preservation.

Major bank erosion exists on 44 miles of the 4.4 thousand miles of streams and rivers in the Area. An estimated 9,200 acres of buffer strips would prevent bank overfall and filter sediment. Streambank erosion control includes clearing and snagging, riprap, channel lining, drop spillways and vegetated banks.





Coastal changes have been minimized by jetty structures. Only 1 of the 10 mile unstable shoreline is classed as critical. Sand fill is needed to replenish the beaches.

EROSION CONTROL DEMANDS USED IN PLAN FORMULATION

Objective	Time Frame Year	Planned Land Use Preserved: 1000 Ac.	Planned Land Use Adjust: 1000 Ac.	Land Treatment for Erosion Control — Conservation Land Treatment: Cropland: 1000 Ac.	Past-ure: 1000 Ac.	Forest: 1000 Ac.	Other: 1000 Ac.	Urban: 1000 Ac.	Total: 1000 Ac.	Installation: Initial Cost $ Million	Installation: Ave* Ann. $ Million	Streambank Erosion Control: Treatment Mile	Streambank Erosion Control: Initial Cost $ Mil.	Shoreline Protection: Treatment Mile	Shoreline Protection: Initial Cost $ Mil.
Adequately treated or not feasible to treat	1966	3		14	2	23	6	273	318			4213	**	-	
NATIONAL EFFICIENCY	1980	5	<1	15	-	-	-	53	68	9.1	.7	1	.1	-	
	2000	-	-	7	-	-	-	111	118	18.2	1.2	2	.1	-	
	2020	-	-	1	-	-	-	172	173	27.7	1.7	2	.1	-	
REGIONAL DEVELOPMENT	1980	5	5	19	3	-	16	133	171	24.2	1.8	2	.1	-	
	2000	-	-	8	1	-	16	139	164	24.2	1.7	4	.3	-	
	2020	-	-	1	1	-	11	215	228	35.7	2.2	4	.3	-	
ENVIRONMENTAL QUALITY	1980	5	5	19	3	-	16	133	171	24.2	1.8	4	.3	4	7.9
	2000	-	-	8	1	-	16	139	164	24.2	1.7	9	.7	4	7.9
	2020	-	-	1	1	-	11	215	228	35.7	2.2	9	.7	-	

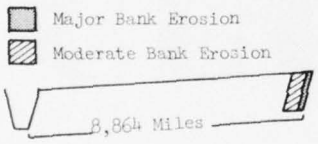
NOTE: The values shown in the table are incremental. Price Base 1970.
* Initial cost amortized at 5-1/8% project life plus Operation & Maintenance.
** Negligible erosion or stable.

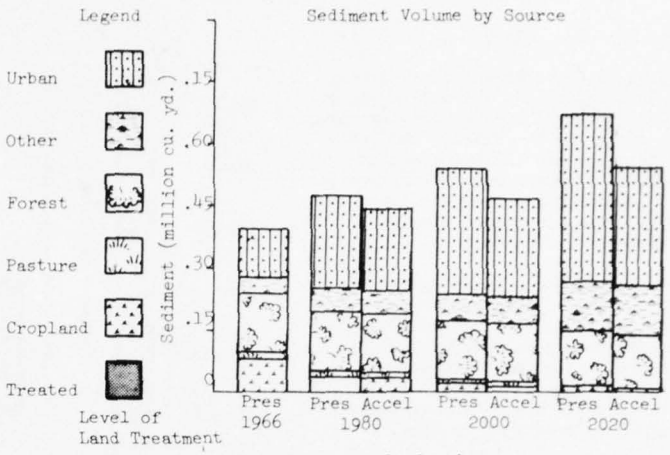
SUBREGION B - AREA 8

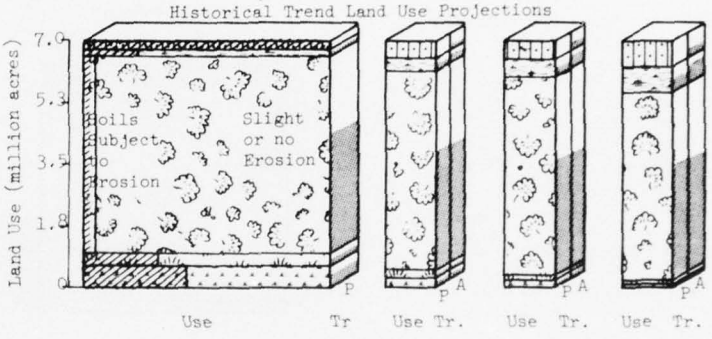
Erosion is the dominant soil hazard on 10% of the Area's 7.0 million acres. An estimated 32% of the sediment comes from these 676,000 acres. The 20% row crops of the 598,000 acres of cropland, 35,000 acres of construction areas, and 3,400 acres of critical erosion areas are particularly vulnerable to erosion.

Land use adjustments are needed on 72,000 acres (rates exceeding twice the allowable soil loss). Present protective cover needs to be maintained on 70,000 acres to prevent excessive erosion. Another 152,000 acres need adequate treatment for erosion control.

Conservation treatment includes: diversions, stripcropping, cover cropping, roadside stabilization, establishment and re-establishment of grass, trees, and shrubs, settling and debris basins, grade control structures, and wildlife habitat and development and preservation.







Major bank erosion exists on 98 miles of the 8.9 thousand miles of streams and rivers in the Area. An estimated 18,900 acres of buffer strips would prevent bank overfall and filter sediment. Streambank erosion control includes clearing and snagging, riprap, channel lining, drop spillways and vegetated banks.

EROSION CONTROL DEMANDS USED IN PLAN FORMULATION

Objective	Time Frame Year	Planned Land Use: Pre-served: 1000 Ac.	Planned Land Use: Adjust: 1000 Ac.	Land Treatment for Erosion Control — Conservation Land Treatment: Crop-land: 1000 Ac.	Past-ure: 1000 Ac.	Forest: 1000 Ac.	Other: 1000 Ac.	Urban: 1000 Ac.	Total: 1000 Ac.	Installation: Initial Cost $ Million	Installation: Ave* Ann. $ Million	Streambank Erosion Control: Treat-ment Mile	Streambank Erosion Control: Initial Cost $ Mil.
Adequately treated or not feasible to treat	1966	495		147	26	153	17	518	861			8366	**
NATIONAL EFFICIENCY	1980	70	10	28	-	-	-	83	111	14.6	1.1	2	.1
	2000	-	-	14	-	-	-	128	142	21.2	1.5	5	.3
	2020	-	-	4	-	-	-	195	199	31.6	1.9	5	.3
REGIONAL DEVELOPMENT	1980	70	72	41	36	1	62	208	348	48.7	5.0	5	.3
	2000	-	-	22	16	2	62	160	262	35.7	3.4	10	.6
	2020	-	-	4	14	2	98	244	362	51.0	4.3	10	.6
ENVIRONMENTAL QUALITY	1980	70	72	41	36	2	62	208	349	48.8	5.0	10	.6
	2000	-	-	22	16	2	62	160	262	35.7	3.4	20	1.1
	2020	-	-	4	14	1	98	244	361	50.9	4.3	20	1.1

NOTE: The values shown in the table are incremental. Price Base 1970.
* Initial cost amortized at 5-1/8% project life plus Operation & Maintenance.
** Negligible erosion or stable.

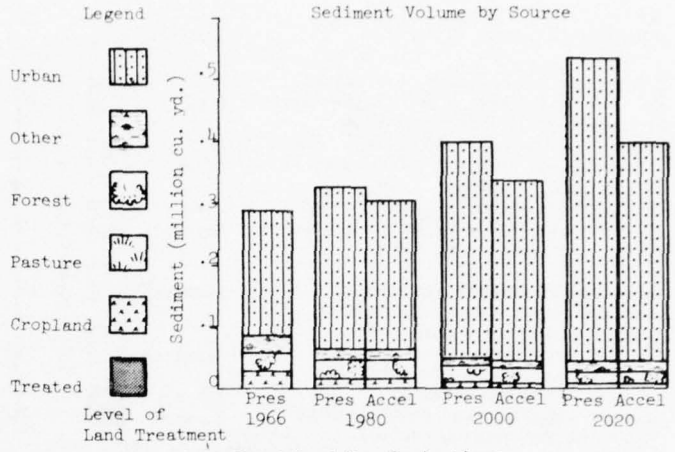
SUBREGION B - AREA 9

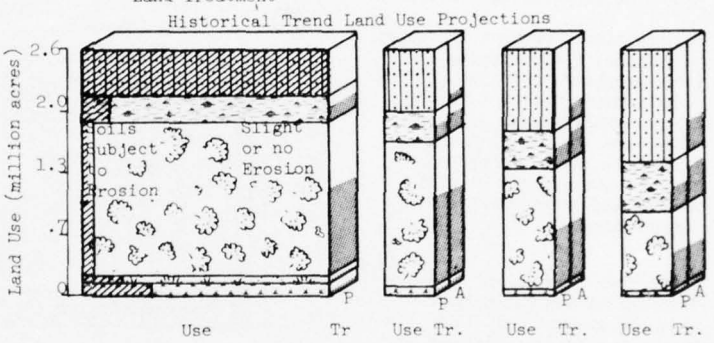
Erosion is the dominant soil hazard on 6% of the Area's 2.6 million acres. An estimated 22% of the sediment comes from these 168,000 acres. The 30% row crops of the 145,000 acres of cropland, 25,000 acres of construction areas, and 500 acres of critical erosion areas are particularly vulnerable to erosion.

Land use adjustments are needed on 2,000 acres (rates exceeding twice the allowable soil loss). Present protective cover needs to be maintained on 1,000 acres to prevent excessive erosion. Another 52,000 acres need adequate treatment for erosion control.

Conservation treatment includes; diversions, stripcropping, cover cropping, roadside stabilization, establishment and re-establishment of grass, trees, and shrubs, settling and debris basins, grade control structures, and wildlife habitat and development and preservation.

Major bank erosion exists on 46 miles of the 4.0 thousand miles of streams and rivers in the Area. An estimated 8,400 acres of buffer strips would prevent bank overfall and filter sediment. Streambank erosion control includes clearing and snagging, riprap, channel lining, drop spillways and vegetated banks.





The shoreline ranges from unconsolidated glacial materials susceptible to rapid movement by storms to the cliff areas in excess of 100 feet above sea level. About 11% of the 1380 miles of shoreline need critical erosion protection. Forty miles are considered stable. Protective measures include stone revetment, seawalls, sand fill and sand fencing.

EROSION CONTROL DEMANDS USED IN PLAN FORMULATION

Objective	Time Frame Year	Planned Land Use: Pre-served: 1000 Ac.	Adjust: 1000 Ac.	Land Treatment for Erosion Control: Conservation Land Treatment: Crop-land: 1000 Ac.	Past-ure: 1000 Ac.	Forest: 1000 Ac.	Other: 1000 Ac.	Urban: 1000 Ac.	Total: 1000 Ac.	Installation: Initial Cost $ Million	Ave* Ann.	Streambank Erosion Control: Treat-ment Mile	Initial Cost $ Mil.	Shoreline Protection: Treat-ment Mile	Initial Cost $ Mil.
Adequately treated or not feasible to treat	1966	36		9	2	43	14	518	586			3784	**	40	**
NATIONAL EFFICIENCY	1980	1	<1	10	-	-	-	56	66	9.4	.6	1	.1	3	5.3
	2000	-	-	6	-	-	-	180	186	29.3	1.9	2	.2	8	14.2
	2020	-	-	1	-	-	-	278	279	44.8	2.7	2	.2	8	14.2
REGIONAL DEVELOPMENT	1980	1	2	13	3	-	12	139	167	24.6	1.8	2	.2	8	14.2
	2000	-	-	7	1	-	12	225	245	37.7	2.5	5	.5	15	26.5
	2020	-	-	1	1	-	16	348	366	57.5	3.6	5	.5	15	26.5
ENVIRONMENTAL QUALITY	1980	1	2	13	3	-	12	139	167	24.6	1.8	5	.5	536	948.1
	2000	-	-	7	1	-	12	225	245	37.7	2.5	9	.9	551	974.6
	2020	-	-	1	1	-	16	348	366	57.5	3.6	9	.9	31	54.8

NOTE: The values shown in the table are incremental. Price Base 1970.
* Initial cost amortized at 5-1/8% project life plus Operation & Maintenance.
** Negligible erosion or stable.

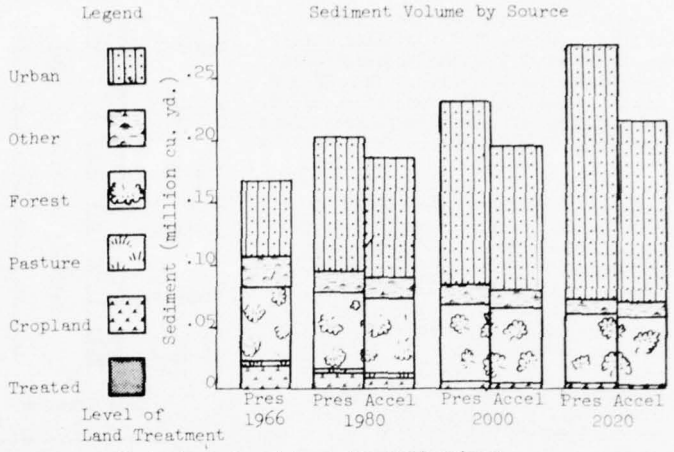
SUBREGION B - AREA 10

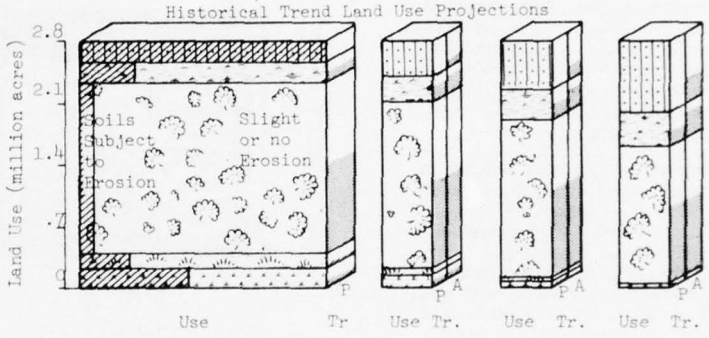
Erosion is the dominant soil hazard on 12% of the Area's 2.8 million acres. An estimated 36% of the sediment comes from these 333,000 acres. The 20% row crops of the 237,000 acres of cropland, 33,000 acres of construction areas, and 3,800 areas of critical erosion areas are particularly vulnerable to erosion.

Land use adjustments are needed on 6,000 acres (rates exceeding twice the allowable soil loss). Present protective cover needs to be maintained on 22,000 acres to prevent excessive erosion. Another 130,000 acres need adequate treatment for erosion control.

Conservation treatment includes: diversions, stripcropping, cover cropping, roadside stabilization, establishment and re-establishment of grass, trees, and shrubs, settling and debris basins, grade control structures, and wildlife habitat and development and preservation.

Major bank erosion exists on 48 miles of the 4.1 thousand miles of streams and rivers in the Area. An estimated 8,600 acres of buffer strips would prevent bank overfall and filter sediment. Streambank erosion control includes clearing and snagging, riprap, channel lining, drop spillways and vegetated banks.





The shoreline varies from rock outcrops to sandy barrier beaches fronting low marshes. About 9% of the 270 miles of shoreline are considered critically unstable. There are only 5 miles stable. Protective measures include stone and timber groins, bulkheads, and jetty or breakwater structures.

EROSION CONTROL DEMANDS USED IN PLAN FORMULATION

Objective	Time Frame Year	Planned Land Use: Pre-served 1000 Ac.	Planned Land Use: Adjust 1000 Ac.	Land Treatment for Erosion Control — Conservation Land Treatment: Crop-land 1000 Ac.	Past-ure 1000 Ac.	Forest 1000 Ac.	Other 1000 Ac.	Urban 1000 Ac.	Total 1000 Ac.	Installation Cost: Initial $ Million	Installation Cost: Ave* Ann. $ Million	Streambank Erosion Control: Treatment Mile	Streambank Erosion Control: Initial Cost $ Mil.	Shoreline Protection: Treatment Mile	Shoreline Protection: Initial Cost $ Mil.
Adequately treated or not feasible to treat	1966	24		26	8	64	17	249	364			3863**		5**	
NATIONAL EFFICIENCY	1980	22	1	22	-	-	-	78	100	13.5	.9	1	.1	-	-
	2000	-	-	11	-	-	-	119	130	19.7	1.3	2	.1	1	1.6
	2020	-	-	1	-	-	-	190	191	30.6	1.8	2	.1	1	1.6
REGIONAL DEVELOPMENT	1980	22	6	27	9	-	23	195	254	36.5	2.6	2	.1	1	1.6
	2000	-	-	13	4	-	24	149	190	27.4	1.8	5	.1	2	3.2
	2020	-	-	1	4	-	14	237	256	40.3	2.5	5	.1	2	3.2
ENVIRONMENTAL QUALITY	1980	22	6	27	9	-	23	195	254	36.5	2.6	5	.1	72	114.0
	2000	-	-	13	4	-	24	149	190	27.4	1.8	10	.2	74	117.2
	2020	-	-	1	4	-	14	237	256	40.3	2.5	10	.2	5	7.9

NOTE: The values shown in the table are incremental. Price Base 1970.
* Initial cost amortized at 5-1/8% project life plus Operation & Maintenance.
** Negligible erosion or stable.

SUBREGION C (Areas 11, 12, and 13)

Land Erosion

Existing Conditions

The inherent erodibility of the soils in Subregion C is slightly below the average for the Region. The topography is nearly level to steep. The average maximum 2-year, 30-minute rainfall is 0.9 inches, about the same as Subregion B. Forest land accounts for 60.6 percent of the total land area in Subregion C. Cropland comprises 15.6 percent; pasture, 9.9 percent; other, 7.4 percent; and urban, 6.5 percent. Area 13 has some extreme conditions. About 52 percent of this Area is urban and only 34.3 percent is forested. In Area 13 only 6 percent of the total land area is cropland; but this cropland is the most intensively farmed in the entire Region. A composite crop rotation is three years of potatoes, one year of small grain, one year of hay, and then potatoes again.

Owing to the large amount of urbanization and intensive agriculture, Area 13 has a high erosion rate of 1,242 tons per square mile per year. The rates from Areas 11 and 12 are relatively low so the average annual rate for the Subregion is only 445 tons per square mile.

The average annual sedimentation rate for the Subregion is 33 tons per square mile. Area 13 is high with an annual rate of 93 tons per square mile. Area 11 is low with an annual rate of 15 tons per square mile.

Annual erosion damages are estimated at $2,070,000, 85 percent of which occur in Area 12. Area 12 also contributes most of the sediment damages in the Subregion. The total estimated sediment damages are $2,100,000. Area 12 incurs $1,310,000 of these damages.

Predicted Rates

The average annual erosion rate for the Subregion is expected to increase to 568 tons per square mile by 2020. A shift in land use from cropland to forest actually causes a decline in the annual erosion rate by 1980, to 439 tons per square mile. By 2000, however, the influence of urbanization is expected to cause an increase to 482 tons per square mile per year.

Land treatment will not have too great an effect on the soil loss in Subregion C. Erosion may be reduced only 10 percent to 511 tons per square mile per year by 2020 with an accelerated land treatment program.

The average sedimentation rate is expected to increase to 42 tons per square mile per year by 2020. Area 13 will increase its annual yield to 113 tons per square mile.

Problem Areas

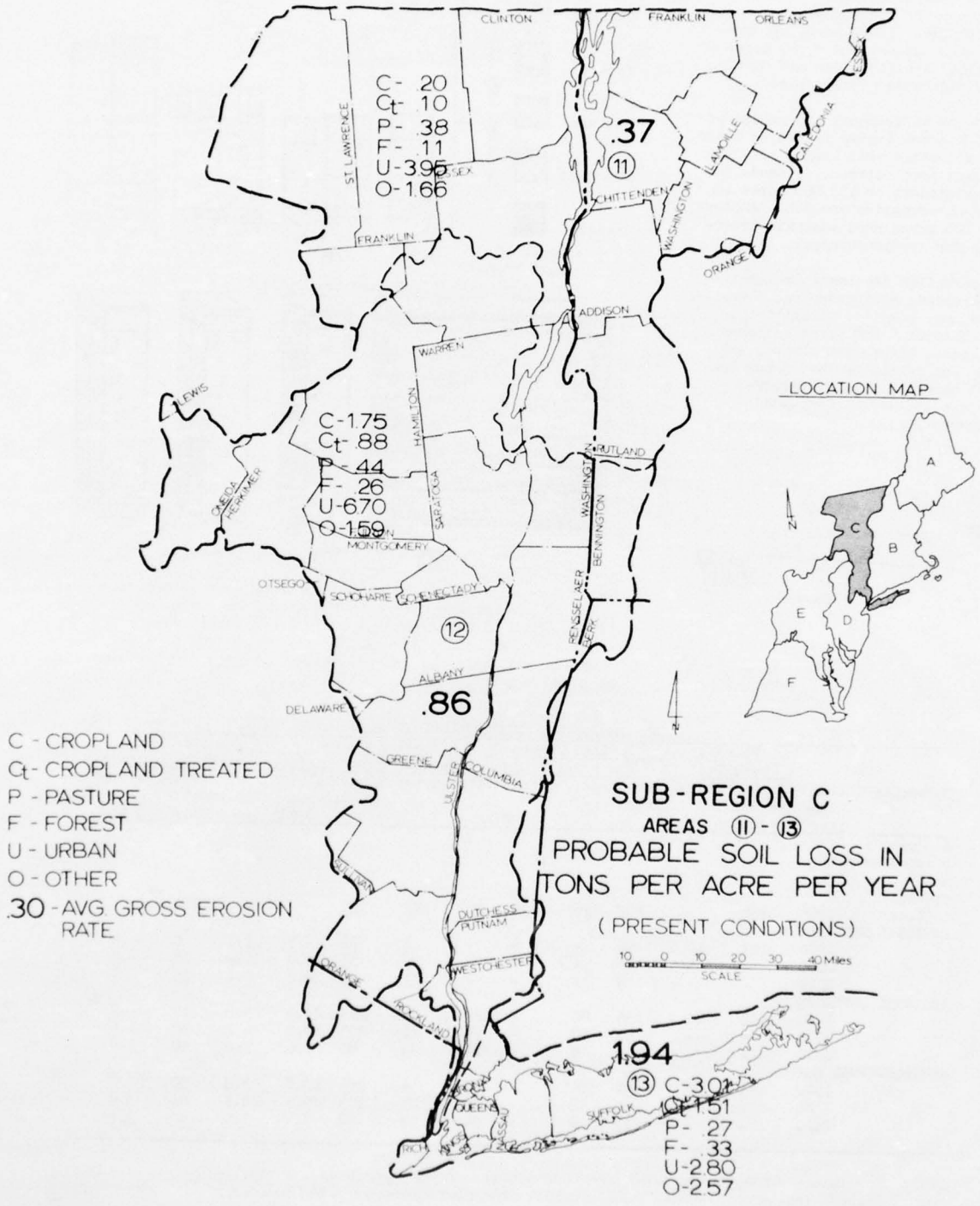
The cropland in Area 13 is a problem area in soil erosion. The erosion rate from the untreated cropland is 3.01 tons per acre per year, slightly greater than the Regional average allowable soil loss.

The total volume of sediment delivered by Subregion C is 1,052,000 cubic yards per year or about 7.5 percent of the total annual volume from the Region. Area 12 delivers more than 60 percent of the sediment from the Subregion; however, it constitutes about 50.3 percent of the Subregion drainage area.

Streambank and Shoreline Erosion

There are 21,060 miles of stream channel in this Subregion. Area 13 (Long Island), has a very small percent of the total mileage and damages. The 680 bank miles of critical erosion result in a total annual damage of about $1.4 million. This is the largest damage area in the Basin. Sedimentation damage and loss of buildings, utilities, fences, etc., account for most of the damage.

Shoreline erosion occurs only in Area 13 and is considered some of the most serious in the entire North Atlantic coastline. The 605 miles of shoreline is all considered unstable and of this 278 miles are classified as being in a critical condition.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Ct- 10
P- 38
F- 11
U-395
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Ct- .88
P- .44
F- .26
U-670
O-159
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(13)
C-3.01
Ct-1.51
P- .27
F- .33
U-2.80
O-2.57
CLINTON
FRANKLIN
ORLEANS
ST LAWRENCE
ESSEX
CHITTENDEN
LAMOILLE
CALEDONIA
WASHINGTON
ORANGE
ADDISON
WARREN
LEWIS
HAMILTON
RUTLAND
OSWEGO
HERKIMER
SARATOGA
WASHINGTON
BENNINGTON
MONTGOMERY
OTSEGO
SCHOHARIE
SCHENECTADY
RENSSELAER
ALBANY
DELAWARE
GREENE
COLUMBIA
ULSTER
DUTCHESS
PUTNAM
ORANGE
WESTCHESTER
ROCKLAND
QUEENS
SUFFOLK
LOCATION MAP
A
B
C
D
E
F
N
C - CROPLAND
Ct - CROPLAND TREATED
P - PASTURE
F - FOREST
U - URBAN
O - OTHER
.30 - AVG GROSS EROSION RATE
SUB-REGION C
AREAS (11) - (13)
PROBABLE SOIL LOSS IN TONS PER ACRE PER YEAR
(PRESENT CONDITIONS)
10 0 10 20 30 40 Miles
SCALE

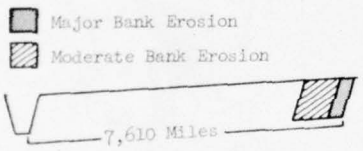
FIGURE Q-9

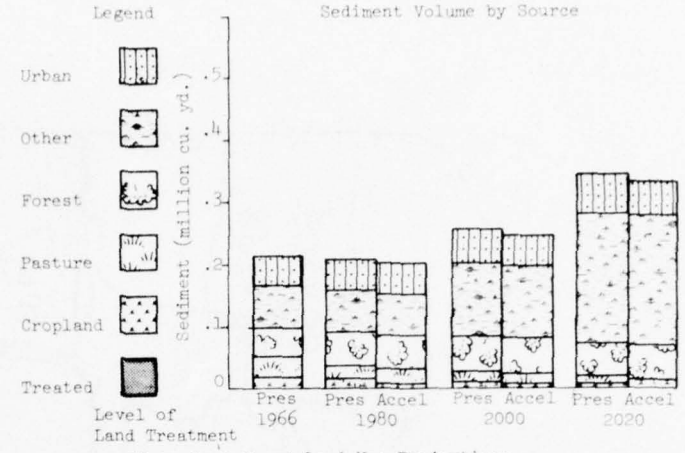
SUBREGION C - AREA 11

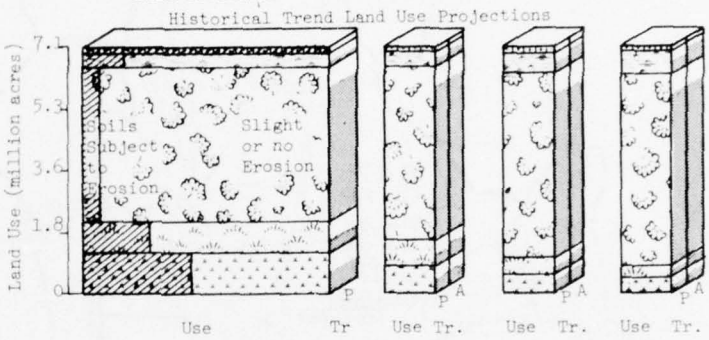
Erosion is the dominant soil hazard on 15% of the Area's 7.1 million acres. An estimated 45% of the sediment comes from these 1.1 million acres. The 10% row crops of the 1.2 million acres of cropland, 1,000 acres of construction areas, and 4,100 acres of critical erosion areas are particularly vulnerable to erosion.

Land use adjustments are needed on 80,000 acres (rates exceeding twice the allowable soil loss). Present protective cover needs to be maintained on 153,000 acres to prevent excessive erosion. Another 486,000 acres need adequate treatment for erosion control.

Conservation treatment includes: diversions, stripcropping, cover cropping, roadside stabilization, establishment and re-establishment of grass, trees, and shrubs, settling and debris basins, grade control structures, and wildlife habitat and development and preservation.







Major bank erosion exists on 300 miles of the 7.6 thousand miles of streams and rivers in the Area. An estimated 17,500 acres of buffer strips would prevent bank overfall and filter sediment. Streambank erosion control includes clearing and snagging, riprap, channel lining, drop spillways and vegetated banks.

EROSION CONTROL DEMANDS USED IN PLAN FORMULATION

Objective	Time Frame Year	Planned Land Use: Preserved 1000 Ac.	Planned Land Use: Adjust 1000 Ac.	Land Treatment for Erosion Control: Conservation Land Treatment: Crop-land 1000 Ac.	Past-ure 1000 Ac.	Forest 1000 Ac.	Other 1000 Ac.	Urban 1000 Ac.	Total 1000 Ac.	Installation: Initial Cost $ Million	Ave* Ann. Treatment Mile	Streambank Erosion Control: Initial Cost $ Mil.
Adequately treated or not feasible to treat	1966	1464		263	76	225	36	132	732		6780	**
NATIONAL EFFICIENCY												
	1980	153	12	96	-	-	-	2	98	3.7	1.1	6	.4
	2000	-	-	68	-	-	-	17	85	5.0	.9	15	.9
	2020	-	-	19	-	-	-	23	42	4.2	.4	15	.9
REGIONAL DEVELOPMENT												
	1980	153	80	134	86	-	29	4	253	23.8	5.8	15	.9
	2000	-	-	95	58	-	29	21	203	19.3	4.1	30	1.8
	2020	-	-	19	8	-	24	29	80	7.6	1.0	30	1.8
ENVIRONMENTAL QUALITY												
	1980	153	80	134	86	-	29	4	253	23.8	5.8	30	1.8
	2000	-	-	95	58	-	29	21	203	19.3	4.1	60	3.6
	2020	-	-	19	8	-	24	29	80	7.6	1.0	60	3.6

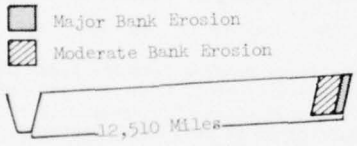
NOTE: The values shown in the table are incremental. Price Base 1970.
* Initial cost amortized at 5-1/8% project life plus Operation & Maintenance.
** Negligible erosion or stable.

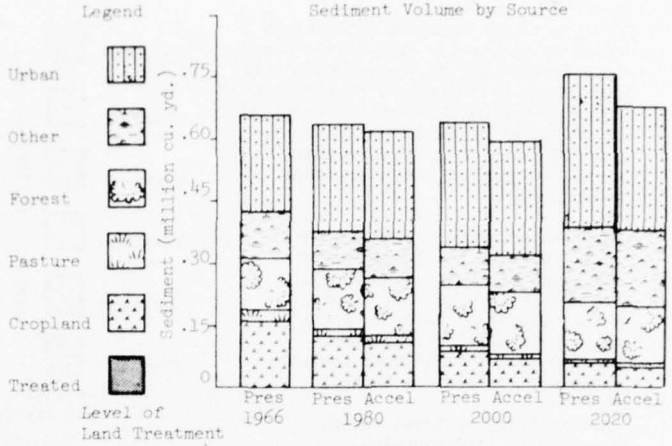
SUBREGION C - AREA 12

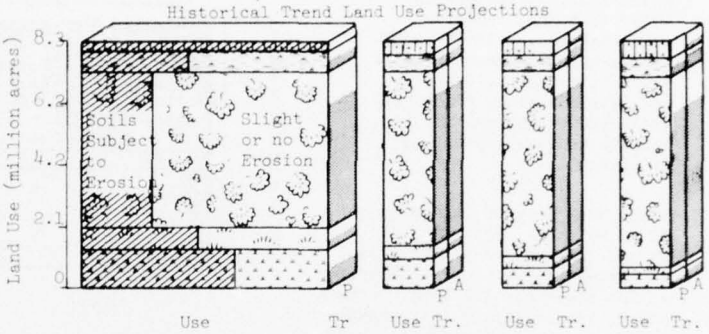
Erosion is the dominant soil hazard on 36% of the Area's 8.3 million acres An estimated 73% of the sediment comes from these 3.0 million acres. The 20% row crops of the 1.3 million acres of cropland, 6,000 acres of construction areas, and 17,000 acres of critical erosion areas are particularly vulnerable to erosion.

Land use adjustments are needed on 162,000 acres (rates exceeding twice the allowable soil loss). Present protective cover needs to be maintained on 778,000 acres to prevent excessive erosion. Another 750,000 acres need adequate treatment for erosion control.

Conservation treatment includes: diversion, stripcropping, cover cropping, roadside stabilization, establishment and re-establishment of grass, trees, shrubs, settling and debris basins, grade control structures, and wildlife habitat and development and preservation.







Major bank erosion exists on 320 miles of the 12.5 thousand miles of streams and rivers in the Area. An estimated 27,500 acres of buffer strips would prevent bank overfall and filter sediment. Streambank erosion control includes clearing and snagging, riprap, channel lining, drop spillways and vegatated banks.

EROSION CONTROL DEMANDS USED IN PLAN FORMULATION

Objective	Time Frame Year	Planned Land Use Pre-served: 1000 Ac.	Planned Land Use Adjust: 1000 Ac.	Land Treatment for Erosion Control — Conservation Land Treatment Crop-land: 1000 Ac.	Past-ure: 1000 Ac.	Forest: 1000 Ac.	Other: 1000 Ac.	Urban: 1000 Ac.	Total: 1000 Ac.	Installation Initial: $ Million	Installation Ave* Ann.: $ Million	Streambank Erosion Control Treat-ment: Mile	Streambank Erosion Control Initial Cost: $ Mil.
Adequately treated or not feasible to treat	1966	1061		378	104	1247	185	390	2304			11580	**
NATIONAL EFFICIENCY	1980	778	20	165	-	-	-	13	178	7.8	1.9	6	.3
	2000	-	-	114	-	-	-	60	174	13.2	1.9	16	.7
	2020	-	-	31	-	-	-	80	111	13.4	1.1	16	.7
REGIONAL DEVELOPMENT	1980	778	162	226	99	4	22	33	384	34.3	7.6	16	.7
	2000	-	-	156	67	5	22	74	324	31.8	5.8	32	1.5
	2020	-	-	31	11	4	67	100	213	21.3	2.2	32	1.5
ENVIRONMENTAL QUALITY	1980	778	162	226	99	4	22	33	384	34.3	7.6	32	1.5
	2000	-	-	156	67	6	22	74	325	31.8	5.8	64	3.0
	2020	-	-	31	11	3	67	100	212	21.2	2.2	64	3.0

NOTE: The values shown in the table are incremental. Price Base 1970.
* Initial cost amortized at 5-1/8% project life plus Operation & Maintenance.
** Negligible erosion or stable.

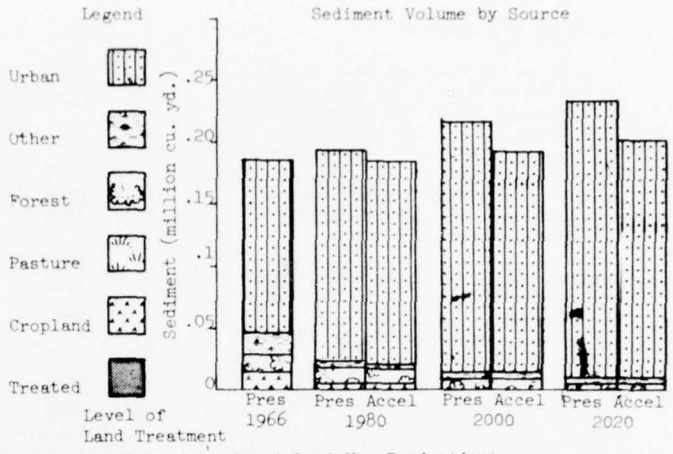
SUBREGION C - AREA 13

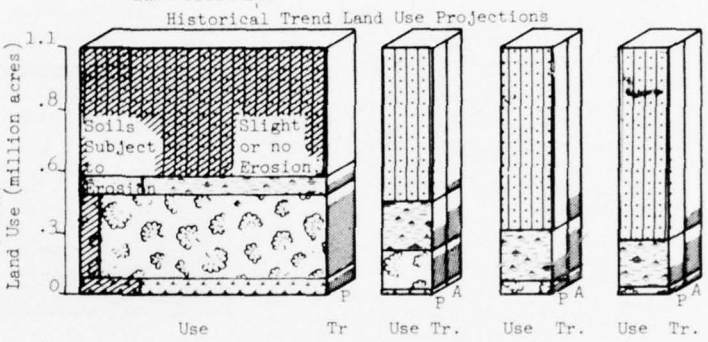
Erosion is the dominant soil hazard on 8% of the Area's 1.1 million acres. An estimated 26% of the sediment comes from these 85,000 acres. The 60% row crops of the 63,000 acres of cropland, 19,000 acres of construction areas, and 200 acres of critical erosion areas are particularly vulnerable to erosion.

Land use adjustments are needed on 1,000 acres (rates exceeding twice the allowable soil loss). Present protective cover needs to be maintained on 2,000 acres to prevent excessive erosion. Another 20,000 acres need adequate treatment for erosion control.

Conservation treatment includes: diversions, stripcropping, vover cropping, roadside stabilization, establishment and re-establishment of grass, trees, and shrubs, settling and debris basins, grade control structures, and wildlife habitat and development and preservation.

Major bank erosion exists on 60 miles of the 940 miles of streams and rivers in the Area. An estimated 2,200 acres of buffer strips would prevent bank overfall and filter sediment. Streambank erosion control includes clearing and snagging, riprap, channel lining, drop spillways and vegetated banks.





The shoreline is very diversified ranging from low tidal marshes, sandy recreational beaches, marina coves, to bluffs 150 feet above sea level. None of the 605 miles of shoreline is considered stable. Nearly half of it is critically unstable. Control measures include vegetative practices, groins, jetties and sand fill.

EROSION CONTROL DEMANDS USED IN PLAN FORMULATION

Objective	Time Frame Year	Planned Land Use: Pre-served 1000 Ac.	Adjust	Land Treatment for Erosion Control: Conservation Land Treatment: Crop-land 1000 Ac.	Past-ure	Forest	Other	Urban	Total	Installation: Initial Cost $ Million	Ave* Ann.	Streambank Erosion Control: Treat-ment Mile	Initial Cost $ Mil.	Shoreline Protection: Treat-ment Mile	Initial Cost $ Mil.
Adequately treated or not feasible to treat	1966	2		14	-	38	6	548	606			** 860		-	
NATIONAL EFFICIENCY															
	1980	2	-	1	-	-	-	43	44	6.6	.4	1	.1	6	3.9
	2000	-	-	-	-	-	-	92	92	14.2	.9	3	.1	14	9.0
	2020	-	-	-	-	-	-	41	41	6.3	.4	3	.1	14	9.0
REGIONAL DEVELOPMENT															
	1980	2	1	1	-	-	28	107	136	17.5	1.2	3	.1	14	9.0
	2000	-	-	-	-	-	28	115	143	18.7	1.3	6	.1	28	18.0
	2020	-	-	-	-	-	-	51	51	7.9	.5	6	.1	28	18.0
ENVIRONMENTAL QUALITY															
	1980	2	1	1	-	-	28	107	136	17.5	1.2	6	.1	156	100.3
	2000	-	-	-	-	-	28	115	143	18.7	1.3	12	.2	185	119.0
	2020	-	-	-	-	-	-	51	51	7.9	.5	12	.2	56	36.0

NOTE: The values shown in the table are incremental. Price Base 1970.
* Initial cost amortized at 5-1/8% project life plus Operation & Maintenance.
** Negligible erosion or stable.

SUBREGION D (Areas 14, 15, and 16)

Land Erosion

Existing Conditions

The soils in this Subregion have an average soil erodibility factor when compared with the other Subregions. The factor for these soils is 0.25. The topography is generally gentle to moderate with the exception of some of the forested areas of Area 15 which are steep. The average maximum 2-year, 30-minute rainfall is about 1.1 inches. Land use has the greatest influence on the erosion rates in this Subregion. Subregion D has the highest percentage of urban land with 13.4 percent. It has the second highest percentage of cropland with 20.8 percent. Conversely, the forest land use is the lowest in the Region, 49.8 percent. Other lands and pasture have 11.2 and 4.8 percent respectively.

The agricultural land in Subregion D is the most intensively farmed in the Region. A composite crop rotation is two years of corn silage, a year of small grain, and then three or four years of hay; or, in the case of Area 16, three years of corn, a year of small grain, and only two years of hay.

The average annual erosion rate for Subregion D is 1,459 tons per square mile. The rates from the Areas within the Subregion range from 685 tons per square mile in Area 16 to 1,645 tons per square mile in Area 14, the highest rate in the entire Region.

Sedimentation rates for Areas 14, 15, and 16 are 123, 117, and 51 tons per square mile per year, averaging 109 tons of sediment annually from each square mile of land area within the Subregion.

Erosion damages are estimated at $9,650,000 in Subregion D, about 85 percent of which occur in Area 15. Sediment damages in the Subregion are approximately $4,470,000 annually. Area 15 receives 79 percent of these damages, about $3,600,000 every year.

Predicted Rates

Subregion D is the most rapidly changing in the Region as far as the land use is concerned. By 2020, over 29 percent of the total land area will be urban and only 6.7 percent will be cropland. Area 14 will have over 75 percent of its land area in urban development. This rapid urbanization will have a tremendous effect on the erosion rates in the future. In Area 14 the predicted erosion rate will increase about 82 percent to 2,982 tons per square mile per year by 2020. The increase will not be as great in Areas 15 and 16.

An accelerated land treatment program will have a considerable effect on the erosion rates. In Area 14 the rate of erosion still increases but at a slower rate. The annual erosion rate will be 2,259 tons per square mile in Area 14 by 2020, an increase of 37 percent. Areas 15 and 16 show a decrease in the erosion rate by 1980 and then steady increases to 2020. However, neither of these two Areas is ever expected to return to the present rate of erosion. This can be attributed to the large total area of urban land and a reduction in the total acreage of cropland. Accelerated land treatment can reduce erosion as much as 18.8 percent in Subregion D by 2020. The greatest effect will be felt in Area 14 where erosion rates can be reduced 24.2 percent.

Sedimentation rates will increase to 142 tons per square mile per year by 2020 in Subregion D, an increase of 30 percent. The greatest increase is 82 percent in Area 14.

Problem Areas

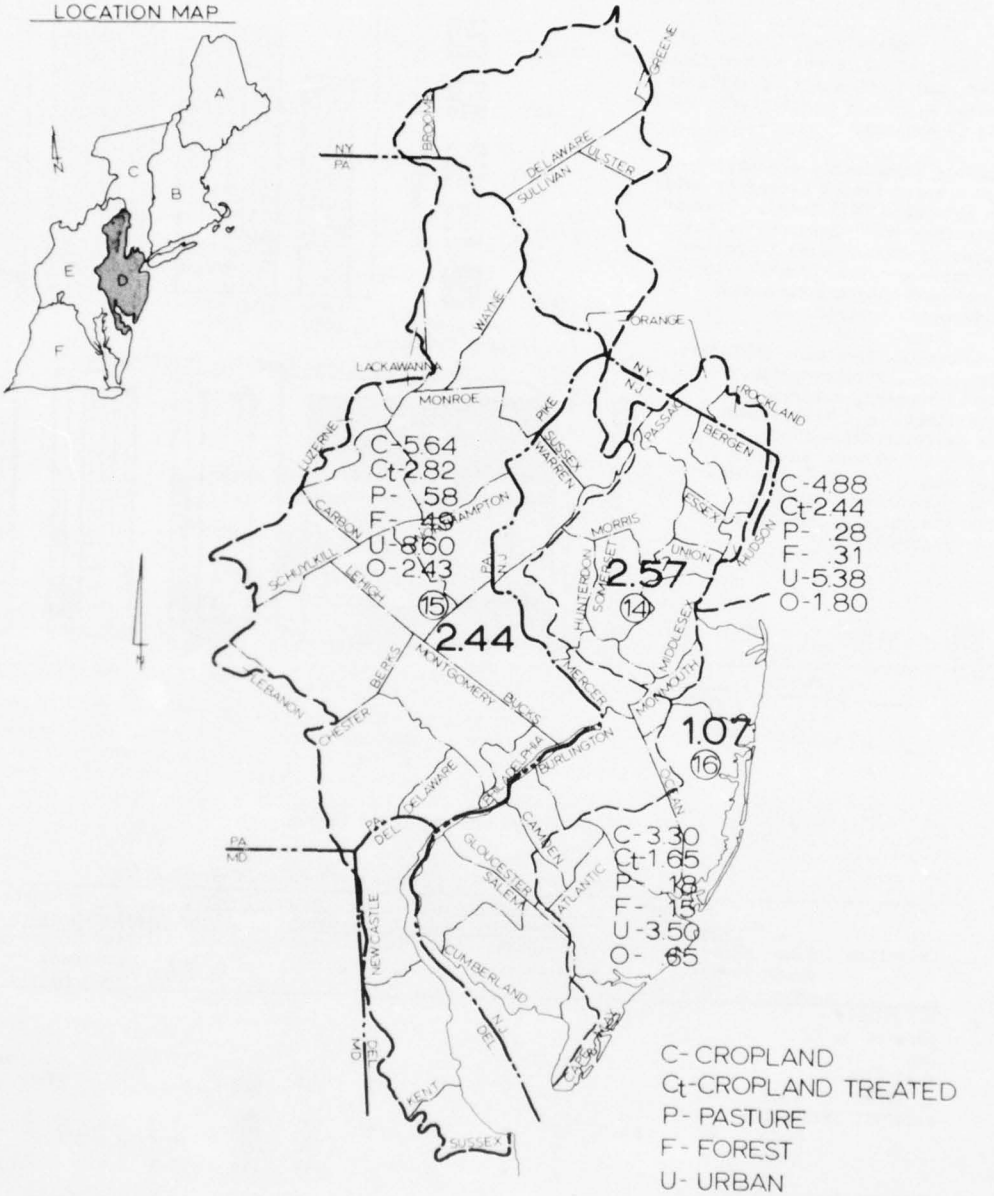
Areas 14, 15, and 16 all have erosion problem areas. The erosion rates from the cropland in these areas all exceed the allowable soil loss. Area 15 has the most severe problem with an annual rate of 5.64 tons per acre from its cropland.

Subregion D contributes about 16 percent of the total sediment from the Region. The major portion of this sediment comes from Area 15.

Streambank and Shoreline Erosion

There are about 18,980 miles of stream channels in Subregion D. Approximately 1,130 bank miles have major erosion problems and contribute to the $280,000 annual damages. As would be expected in an area with more urban land, a substantial part of this damage is due to houses, roads, and utilities being damaged.

The New Jersey coastline is another area experiencing numerous critical erosion problems. In this Subregion 169 miles of the 701 miles of shoreline are considered to be critical and in need of treatment. Most of this is along the east coast of New Jersey.



SUB-REGION D

AREAS (14) - (16)

PROBABLE SOIL LOSS IN TONS PER ACRE PER YEAR

(PRESENT CONDITIONS)

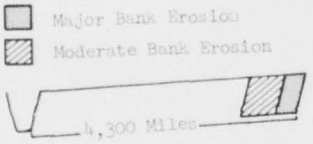
FIGURE Q-10

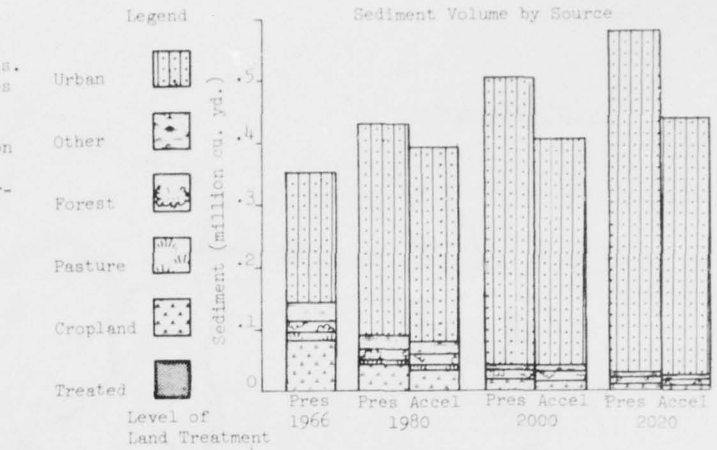
SUBREGION D - AREA 14

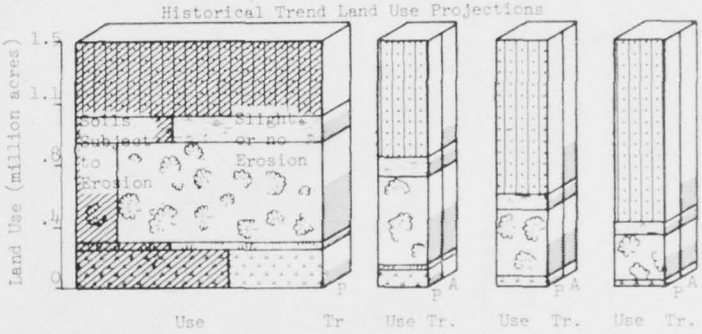
Erosion is the dominant soil hazard on 24% of the Area's 1.5 million acres. An estimated 57% of the sediment comes from these 351,000 acres. The 30% row crops of the 229,000 acres of cropland, 47,000 acres of construction areas, and 1,000 acres of critical erosion areas are particularly vulnerable to erosion.

Land use adjustments are needed on 27,000 acres (rates exceeding twice the allowable soil loss). Present protective cover needs to be maintained on 22,000 acres to prevent excessive erosion. Another 105,000 acres need adequate treatment for erosion control.

Conservation treatment includes: diversions, stripcropping, cover cropping, roadside stabilization, establishment and re-establishment of grass, trees, and shrubs, settling and debris basins, grade control structures, and wildlife habitat and development and preservation.







Major bank erosion exists on 370 miles of the 4.3 thousand miles of streams and rivers in the Area. An estimated 10,400 acres of buffer strips would prevent bank overfall and filter sediment. Streambank erosion control includes clearing and snagging, riprap, channel lining, drop spillways and vegetated banks.

EROSION CONTROL DEMANDS USED IN PLAN FORMULATION

Objective	Time Frame: Year	Planned Land Use: Pre-served: 1000 Ac.	Planned Land Use: Adjust: 1000 Ac.	Land Treatment for Erosion Control — Conservation Land Treatment: Crop-land: 1000 Ac.	Past-ure: 1000 Ac.	Forest: 1000 Ac.	Other: 1000 Ac.	Urban: 1000 Ac.	Total: 1000 Ac.	Installation: Initial Cost $ Million	Installation: Ave* Ann. Treat-ment Mile	Streambank Erosion Control: Initial Cost $ Mil.
Adequately treated or not feasible to treat	1966	13		62	9	52	41	448	612			3750 **
NATIONAL EFFICIENCY	1980	22	3	19	-	-	-	106	125	17.3	1.3	7 .2
	2000	-	-	9	-	-	-	182	191	28.6	2.0	18 .5
	2020	-	-	2	-	-	-	142	144	22.1	1.4	18 .5
REGIONAL DEVELOPMENT	1980	22	27	26	3	-	-	264	293	42.6	3.1	18 .5
	2000	-	-	12	2	-	-	227	241	36.0	2.5	37 1.0
	2020	-	-	2	1	-	-	177	180	27.6	1.7	37 1.0
ENVIRONMENTAL QUALITY	1980	22	27	26	3	-	-	264	293	42.6	3.1	37 1.0
	2000	-	-	12	2	-	-	227	241	36.0	2.5	74 2.0
	2020	-	-	2	1	-	-	177	180	27.6	1.7	74 2.0

NOTE: The values shown in the table are incremental. Price Base 1970.
* Initial cost amortized at 5-1/8% project life plus Operation & Maintenance.
** Negligible erosion or stable.

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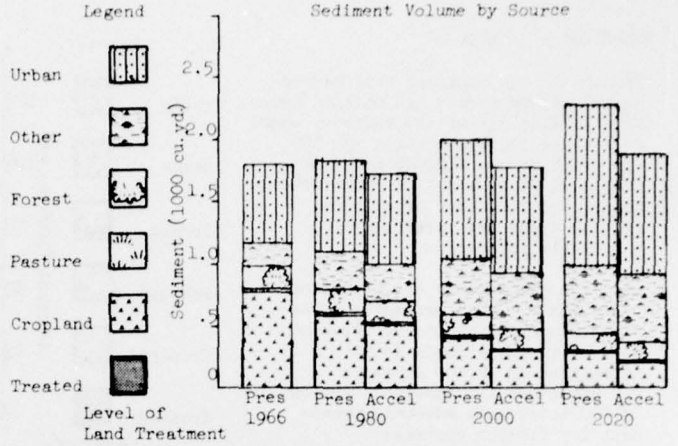
SUBREGION D - AREA 15

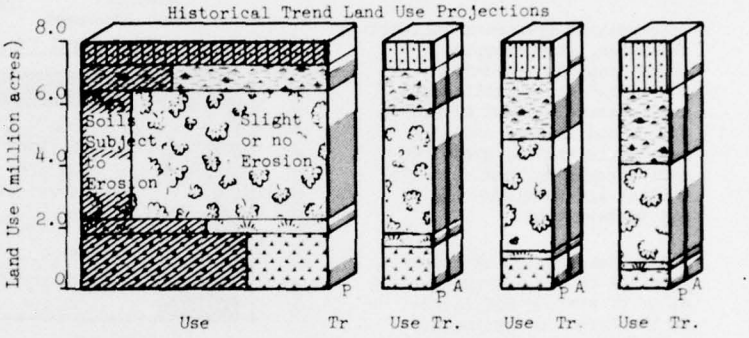
Erosion is the dominant soil hazard on 33% of the Area's 8.0 million acres. An estimated 69% of the sediment comes from these 2.6 million acres. The 35% row crops of the 1.8 million acres of cropland, 25,000 acres of construction areas, and 24,000 acres of critical erosion areas are particularly vulnerable to erosion.

Land use adjustments are needed on 233,000 acres (rates exceeding twice the allowable soil loss). Present protective cover needs to be maintained on 264,000 acres, to prevent excessive erosion. Another 946,000 acres need adequate treatment for erosion control.

Conservation treatment includes: diversions, stripcropping, cover cropping, roadside stabilization, establishment and re-establishment of grass, trees, and shrubs, settling and debris basins, grade control structures, and wildlife habitat and development and preservation.

Major bank erosion exists on 680 miles of the 12.1 thousand miles of streams and rivers in the Area. An estimated 29,800 acres of buffer strips would prevent bank overfall and filter sediment. Streambank erosion control includes clearing and snagging, riprap, channel lining, drop spillways and vegetated banks.





Most of the area is not on the open ocean. The bay shoreline erosion is normally a gradual process with soil being removed by the daily action of the littoral forces. Thirty miles of the 299 miles of shoreline are critically unstable. Shoreline improvements include beach fill, groins, sand fences and dune grass plantings.

EROSION CONTROL DEMANDS USED IN PLAN FORMULATION

Objective	Time Frame Year	Planned Land Use: Pre-served 1000 Ac.	Planned Land Use: Adjust 1000 Ac.	Land Treatment for Erosion Control — Conservation Land Treatment: Crop-land 1000 Ac.	Past-ure 1000 Ac.	Forest 1000 Ac.	Other 1000 Ac.	Urban 1000 Ac.	Total 1000 Ac.	Installation: Initial Cost $ Million	Installation: Ave* Ann. Cost $ Million	Streambank Erosion Control: Treat-ment Mile	Streambank Erosion Control: Initial Cost $ Mil.	Shoreline Protection: Treat-ment Mile	Shoreline Protection: Initial Cost $ Mil.
Adequately treated or not feasible to treat	1966	230		464	120	595	226	799	2204			9960	**	221	**
NATIONAL EFFICIENCY	1980	264	94	284	-	-	-	56	340	22.6	5.3	14	.4	1	1.5
	2000	-	-	194	-	-	-	236	430	46.1	5.6	34	1.0	2	3.0
	2020	-	-	45	-	-	-	337	382	54.4	4.1	34	1.0	2	3.0
REGIONAL DEVELOPMENT	1980	264	233	374	63	3	274	141	855	60.5	12.2	34	1.0	2	3.0
	2000	-	-	255	42	3	274	295	869	75.5	10.8	68	2.0	3	4.4
	2020	-	-	45	7	2	150	422	626	74.7	6.2	68	2.0	3	4.4
ENVIRONMENTAL QUALITY	1980	264	233	374	63	3	274	141	855	60.5	12.2	68	2.0	42	62.1
	2000	-	-	255	42	4	274	295	870	75.6	10.8	136	4.0	45	66.5
	2020	-	-	45	7	1	150	422	625	74.7	6.2	136	4.0	6	8.9

NOTE: The values shown in the table are incremental. Price Base 1970.
* Initial cost amortized at 5-1/8% project life plus Operation & Maintenance.
** Negligible erosion or stable.

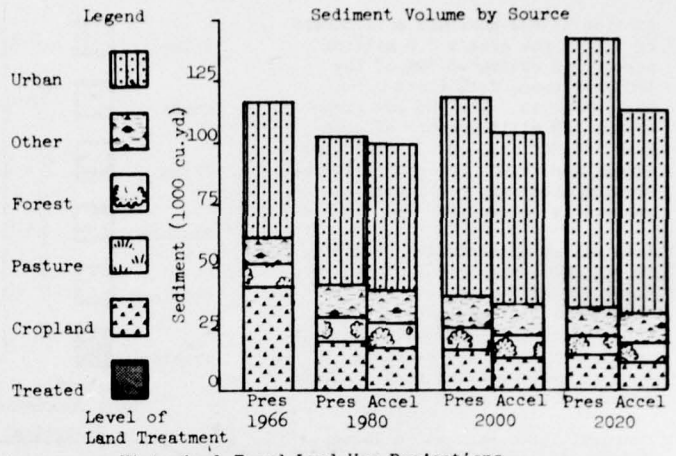
SUBREGION D - AREA 16

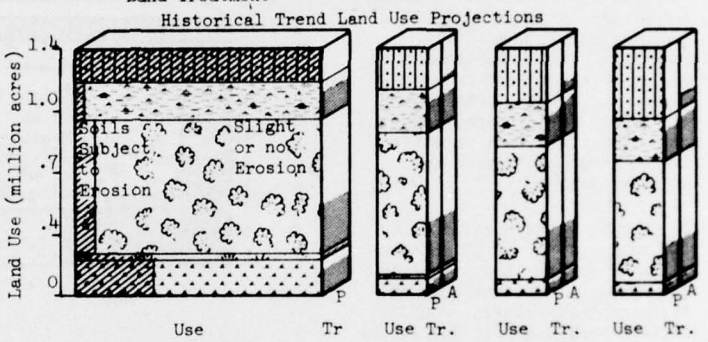
Erosion is the dominant soil hazard on 10% of the Area's 1.4 million acres. An estimated 33% of the sediment comes from these 145,000 acres. The 50% row crops of the 212,000 acres of cropland, 4,000 acres of construction areas, and 200 acres of critical erosion areas are particularly vulnerable to erosion.

Land use adjustments are needed on 5,000 acres (rates exceeding twice the allowable soil loss). Present protective cover needs to be maintained on 12,000 acres to prevent excessive erosion. Another 27,000 acres need adequate treatment for erosion control.

Conservation treatment includes: diversion, stripcropping, cover cropping, roadside stabilization, establishment and re-establishment of grass, trees, and shrubs, settling and debris basins, grade control structures, and wildlife habitat and development and preservation.

Major bank erosion exists on 80 miles of the 2.6 thousand miles of streams and rivers in the Area. An estimated 5,700 acres of buffer strips would prevent bank overfall and filter sediment. Streambank erosion control includes clearing and snagging, riprap, channel lining, drop spillways and vegetated banks.





The shoreline is characterized by sandy barrier islands, tidal marshes, back bays, low sandy beaches and the high bluffs at Sandy Hook. About 55% of the 402 miles of shoreline are unstable, with 139 miles being classified as critical. Protective measures include sand fill, bulkheading, groins, revetment and vegetative practices.

EROSION CONTROL DEMANDS USED IN PLAN FORMULATION

Objective	Time Frame Year	Planned Land Use: Pre-served 1000 Ac.	Planned Land Use: Adjust 1000 Ac.	Land Treatment for Erosion Control: Conservation Land Treatment 1000 Ac.: Crop-land	Past-ure	Forest	Other	Urban	Total	Installation Cost $ Million	Streambank Erosion Control: Ave. Ann. Treatment Mile	Streambank Erosion Control: Initial Cost $ Mil.	Shoreline Protection: Treatment Mile	Shoreline Protection: Initial Cost $ Mil.
Adequately treated or not feasible to treat	1966	39		49	3	23	20	204	299			**		**
NATIONAL EFFICIENCY														
	1980	12	3	4	-	-	-	8	12	1.4	.2	2	.1	3	2.5
	2000	-	-	4	-	-	-	58	62	9.2	.7	4	.1	7	5.7
	2020	-	-	2	-	-	-	80	82	12.5	.8	4	.1	7	5.7
REGIONAL DEVELOPMENT														
	1980	12	5	7	-	-	2	21	30	3.7	.3	4	.1	7	5.7
	2000	-	-	7	-	-	2	72	81	11.6	.8	8	.3	14	11.5
	2020	-	-	2	-	-	-	100	102	15.6	1.0	8	.3	14	11.5
ENVIRONMENTAL QUALITY														
	1980	12	5	7	-	-	2	21	30	3.7	.3	8	.3	92	75.3
	2000	-	-	7	-	-	2	72	81	11.6	.8	16	.6	107	87.6
	2020	-	-	2	-	-	-	100	102	15.6	1.0	16	.6	28	22.9

NOTE: The values shown in the table are incremental. Price Base 1970.
* Initial cost amortized at 5-1/8% project life plus Operation & Maintenance.
** Negligible erosion or stable.

SUBREGION E (Areas 17 and 18)

Land Erosion

Existing Conditions

Subregion E contains soils that are slightly more erodible than the average, having an average soil factor of 0.28. The topography varies between the Areas in this Subregion. Slopes in Area 17 are moderate to steep. Area 18 has considerably less slope ranging from gentle to moderate. Subregion E has the widest range of maximum 2-year, 30-minute rainfall in the Region. The range is from 0.8 to 1.4 inches averaging about 1.1 inches. Subregion E has the highest percentage of cropland in the Region. Cropland comprises 26.2 percent of the total land area of the Subregion. The percentage of urban land is relatively low, 5.1 percent. The remainder of the land uses consist of 52.2 percent forest, 8.9 percent other land, and 7.6 percent pasture.

Agricultural land use ranks second in intensity in the Region. A composite crop rotation is two or three years of corn (for grain), a year of small grains, and then two or three years of hay. Area 18 is cropped more intensively than Area 17.

The average erosion rate from Subregion E is one of the highest in the Region averaging 1,530 tons per square mile per year. Area 18 has the higher rate in the Subregion with 1,626 tons per square mile per year.

Sedimentation rates average 115 tons annually from each square mile of land area in the Subregion. Reservoirs along the lower main stem of the Susquehanna River trap considerable amounts of sediment before entering the Chesapeake Bay.

Subregion E, the largest and most intensively tilled, has the greatest amount of erosion and sedimentation damage in the entire Region. Erosion damages are estimated to be $25,200,000 annually and sediment damages are expected to be about $9,780,000 annually. Approximately 70 percent of the erosion damage and 78 percent of the sediment damage occur in Area 17.

Predicted Rates

Land use will change little in this Subregion. The most significant change will be from cropland to urban. The percentage of cropland will decrease steadily from 26.2 to 12.7 percent by 2020. This is still the highest Subregional percentage of cropland use in the Region. Most of the cropland that is changing use will go to urban, the remainder to forest. The relative stability of the land use patterns is seen in the predicted gross erosion rates. The erosion rates increase to 2020 but at a relatively slow rate. The total increase is 30 percent to 1,989 tons per square mile per year.

Land treatment programs will have the greatest effect in this Subregion. Average erosion rates decrease in 1980 and again in 2000. They increase by 2020 but still stay below present levels. The large amount of cropland is responsible for the drop in erosion rate. The effects of accelerated land treatment can readily be seen on large acreages. The slight increase in 2020 reflects the increase in urbanization. An accelerated land treatment program can reduce soil losses an average of 24.3 percent by 2020. Soil loss in Area 18 can be reduced 31 percent.

By 2020 the annual sedimentation rates are expected to be 144 and 167 tons per square mile for Areas 17 and 18. The average is about 149 tons annually per square mile.

Problem Areas

Both Areas 17 and 18 are problem areas in soil erosion. The rate of erosion from the cropland in these Areas considerably exceeds the allowable soil loss. Untreated cropland in Area 18 has an estimated erosion rate of 5.57 tons per acre per year.

Subregion E, which consists of one-third of the cropland and one-fifth of the land area of the Region, produces 35 percent of the total sediment volume from the Region. Area 17 alone yields 3,796,000 cubic yards of sediment annually.

Streambank and Shoreline Erosion

Streambank erosion is considered major on 1,310 bank miles of the total 30,130 miles of stream channel in this Subregion. Ninety-five percent of the damage occurs in Area 17 where the topography is steeper. Average annual damages are $114,000 and are attributed to land loss and sedimentation.

Approximately 2,099 miles of shore line exist in Area 18. Stable conditions are found along 175 miles, and of the remaining shoreline, 207 miles have critical areas of shoreline erosion. The barrier islands need protection in order to shelter irreplaceable wetland areas. Much of the noncritical erosion is along the somewhat protected Chesapeake Bay.

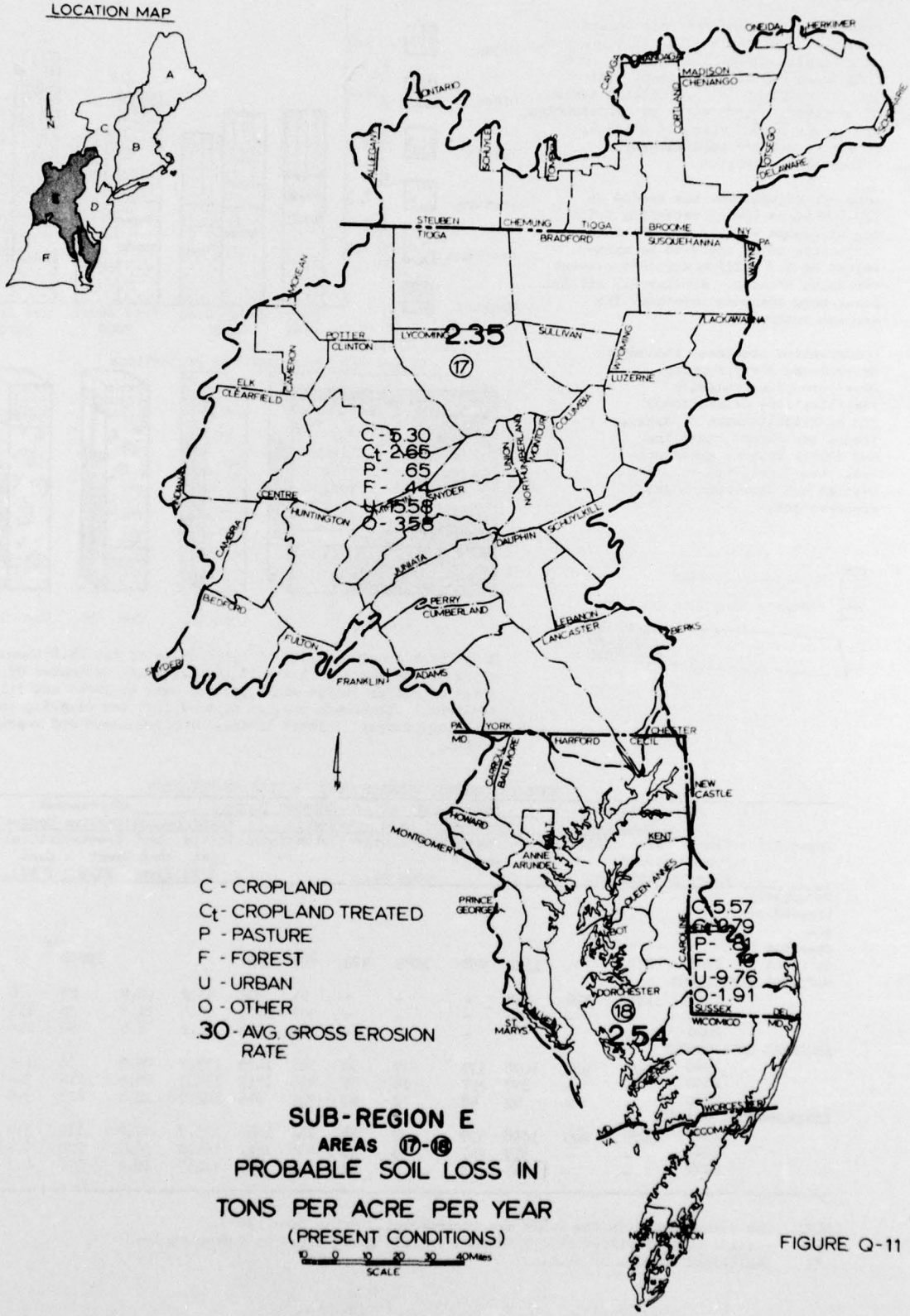

LOCATION MAP
A
B
C
D
E
F
N
2.35
17
C - 5.30
Ct - 2.65
P - .65
F - .44
U - 1.58
O - .38
C - CROPLAND
Ct - CROPLAND TREATED
P - PASTURE
F - FOREST
U - URBAN
O - OTHER
.30 - AVG. GROSS EROSION RATE
C-5.57
P-
F-
U-9.76
O-1.91
18
2.54
SUB-REGION E
AREAS 17-18
PROBABLE SOIL LOSS IN
TONS PER ACRE PER YEAR
(PRESENT CONDITIONS)
10 0 10 20 30 40 Miles
SCALE

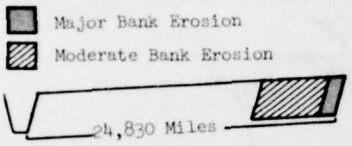
FIGURE Q-11

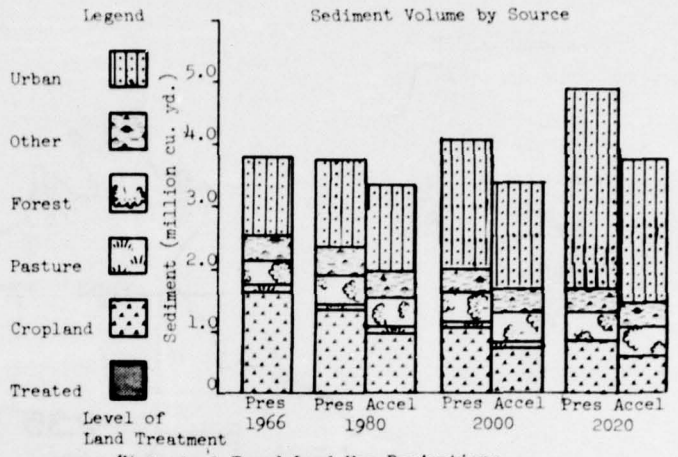
SUBREGION E - AREA 17

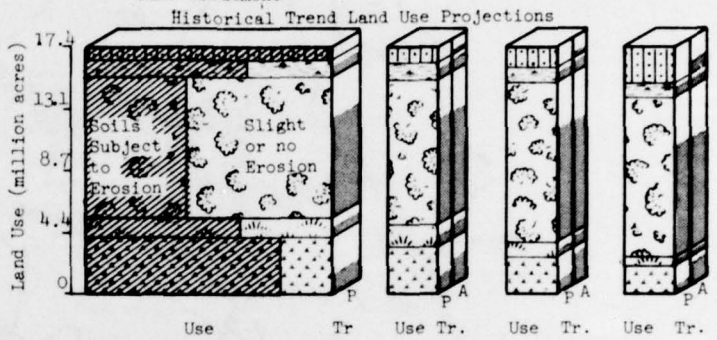
Erosion is the dominant soil hazard on 51% of the Area's 17.4 million acres. An estimated 83% of the sediment comes from these 8.9 million acres. The 35% row crops of the 4.0 million acres of cropland, 28,000 acres of construction areas, and 80,500 acres of critical erosion areas are particularly vulnerable to erosion.

Land use adjustments are needed on 989,000 acres (rates exceeding twice the allowable soil loss). Present protective cover needs to be maintained on 1.7 million acres to prevent excessive erosion. Another 2.9 million acres need adequate treatment for erosion control.

Conservation treatment includes: diversions, stripcropping, cover cropping, roadside stabilization, establishment and re-establishment of grass, trees, and shrubs, settling and debris basins, grade control structures, and wildlife habitat and development and preservation.







Major bank erosion exists on 1,130 miles of the 24.8 thousand miles of streams and rivers in the Area. An estimated 63,000 acres of buffer strips would prevent bank overfall and filter sediment. Streambank erosion control includes clearing and snagging, riprap, channel lining, drop spillways and vegetated banks.

EROSION CONTROL DEMANDS USED IN PLAN FORMULATION

Objective	Time Frame / Year	Planned Land Use: Pre-served (1000 Ac.)	Planned Land Use: Adjust (1000 Ac.)	Land Treatment for Erosion Control: Conservation Land Treatment: Crop-land (1000 Ac.)	Past-ure (1000 Ac.)	Forest (1000 Ac.)	Other (1000 Ac.)	Urban (1000 Ac.)	Total (1000 Ac.)	Installation: Initial Cost $ Million	Ave* Ann.	Streambank Erosion Control: Treat-ment Mile	Initial Cost $ Mil.
Adequately treated or not feasible to treat	1966	615		1172	378	2875	472	883	5780			19280	**
NATIONAL EFFICIENCY													
	1980	1675	326	838	-	-	-	64	902	53.2	10.9	23	.6
	2000	-	-	654	-	-	-	349	1003	86.4	11.5	56	1.5
	2020	-	-	65	-	-	-	585	650	91.2	6.5	56	1.5
REGIONAL DEVELOPMENT													
	1980	1675	989	1098	339	7	54	161	1659	135.7	29.9	56	1.5
	2000	-	-	857	257	14	55	436	1619	152.3	26.3	113	3.0
	2020	-	-	65	48	8	62	731	914	122.9	10.5	113	3.0
ENVIRONMENTAL QUALITY													
	1980	1675	989	1098	339	8	54	161	1660	135.7	29.9	113	3.0
	2000	-	-	857	257	16	55	436	1621	152.5	26.3	230	6.1
	2020	-	-	65	48	5	62	731	911	122.7	10.4	230	6.1

NOTE: The values shown in the table are incremental. Price Base 1970.
* Initial cost amortized at 5-1/8% project life plus Operation & Maintenance.
** Negligible erosion or stable.

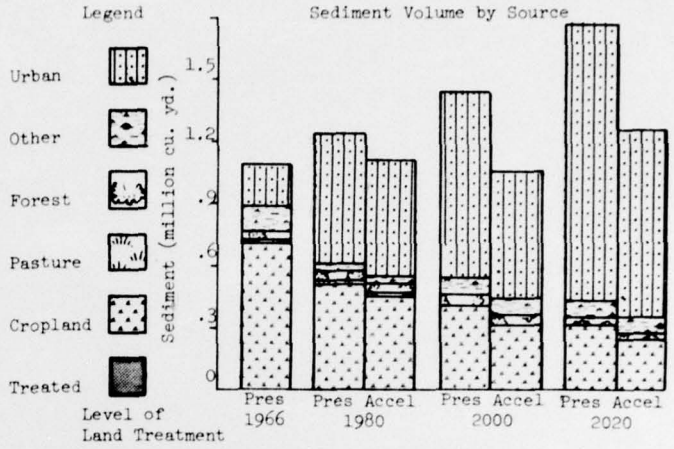
SUBREGION E - AREA 18

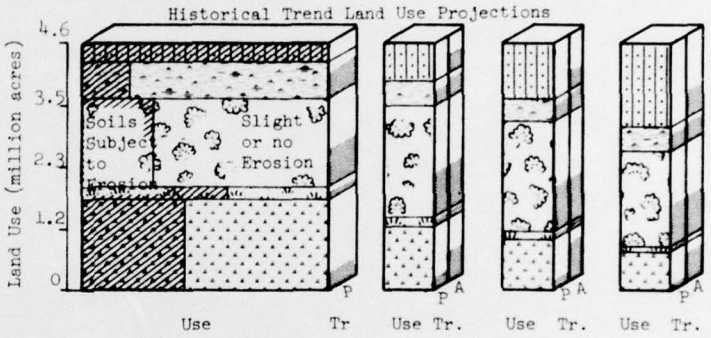
Erosion is the dominant and hazard on 33% of the Area's 4.6 million acres. An estimated 68% of the sediment comes from these 1.5 million acres. The 50% row crops of the 1.8 million acres of cropland, 46,000 acres of construction areas, and 11,700 acres of critical erosion areas are particularly vulnerable to erosion.

Land use adjustments are needed on 99,000 acres (rates exceeding twice the allowable soil loss). Present protective cover needs to be maintained on 192,000 acres to prevent excessive erosion. Another 773,000 acres need adequate treatment for erosion control.

Conservation treatment includes: diversions, stripcropping, cover cropping, roadside stabilization, establishment and re-establishment of grass, trees, and shrubs, settling and debris basins, grade control structures, and wildlife habitat and development and preservation.

Major bank erosion exists on 180 miles of the 5.3 thousand miles of streams and rivers in the Area. An estimated 11,600 acres of buffer strips would prevent bank overfall and filter sediment. Streambank erosion control includes clearing and snagging, riprap, channel lining, drop spillways and vegetated banks.





The 2099 miles of shoreline include the frontage of Chesapeake Bay and the Atlantic Coast from Cape Henlopen to Cape Charles. Brackish marshes encompass much of the bay. The ocean shoreline is protected in many areas by barrier and interior islands. Protective measures such as sand fill are needed on 10% of the area which is critically unstable.

EROSION CONTROL DEMANDS USED IN PLAN FORMULATION

Objective	Time Frame Year	Planned Land Use: Pre-served 1000 Ac.	Planned Land Use: Adjust 1000 Ac.	Land Treatment for Erosion Control: Conservation Land Treatment 1000 Ac.: Crop-land	Past-ure	Forest	Other	Urban	Total	Installation: Initial Cost $ Million	Installation: Ave* Ann.	Streambank Erosion Control: Treat-ment Mile	Streambank Erosion Control: Initial Cost $ Mil.	Shoreline Protection: Treat-ment Mile	Shoreline Protection: Initial Cost $ Mil.
Adequately treated or not feasible to treat	1966	62		114	51	208	175	228	776			4990**		175**	
NATIONAL EFFICIENCY	1980	192	41	240	-	-	-	185	425	40.3	4.8	4	.4	4	1.8
	2000	-	-	187	-	-	-	238	425	45.4	4.6	9	.8	10	4.4
	2020	-	-	37	-	-	-	390	427	60.4	4.3	9	.8	10	4.4
REGIONAL DEVELOPMENT	1980	192	99	295	40	2	-	463	800	91.0	9.8	9	.8	10	4.4
	2000	-	-	230	30	3	-	297	560	61.4	7.0	18	1.6	21	9.2
	2020	-	-	37	6	1	-	487	531	75.9	5.6	18	1.6	21	9.2
ENVIRONMENTAL QUALITY	1980	192	99	295	40	3	-	463	801	91.1	9.8	18	1.6	88	38.6
	2000	-	-	230	30	3	-	297	560	61.4	7.0	36	3.2	110	48.2
	2020	-	-	37	6	-	-	487	530	75.8	5.6	36	3.2	41	18.0

NOTE: The values shown in the table are incremental. Price Base 1970.
* Initial cost amortized at 5-1/8% project life plus Operation & Maintenance.
** Negligible erosion or stable.

SUBREGION F (Areas 19, 20, and 21)

Land Erosion

Existing Conditions

The soils in Subregion F are generally the most erodible in the Region. The average soil factor is 0.33. The topography is gentle to steep. The maximum 2-year, 30-minute rainfall is the highest in the Region, averaging about 1.3 inches. The land use characteristics are similar to Subregion E. There is a relatively high percentage of cropland, 15.4 percent; and low percentage of urban land, 4.3 percent. Forest land comprises the major portion of land use with 64.4 percent of the total land area.

Agriculture is not as intensive as in Subregions D and E. A composite rotation is two years of corn (for grain), a year of small grain, and three or four years of hay.

The annual erosion rate is 1,479 tons per square mile, second only to Subregion E. The rates vary among Areas from 1,152 tons per square mile in Area 20 to 1,574 tons per square mile in Area 19.

Sedimentation rates range from an average of 86 tons per square mile per year in Area 20 to 118 tons per square mile per year in Area 19. The average annual sedimentation rate for the Subregion is 111 tons per square mile.

Erosion damages are approximately $16,400,000 annually, about half of which occur in Area 19. Sedimentation damages are estimated at $8,400,000 annually. About 50 percent of these damages also occur in Area 19.

Predicted Rates

Subregion F is expected to behave very much the same as Subregion E in regard to land use changes. Conditions will remain more stable with the only significant change being from cropland to urban. Cropland will decrease to 8.0 percent of the total land area by 2020, and urban land will increase to 11.4 percent. The increase in the erosion rate for Subregion F will be about 37 percent or 2,028 tons per square mile per year by 2020. The high will be Area 19 with a rate of 2,246 tons per square mile.

Accelerated land treatment will be very effective in Area 19. Erosion can be reduced as much as 36.7 percent with an increased land treatment program. Areas 20 and 21 will not be affected much by land treatment. This is due to low percentages of cropland and urban lands and small relative changes in the amount of urban land.

In Areas 19 and 20 the erosion rates decrease in 1980 and again in 2000 just as occurred in Subregion E. Area 21 increases to 1980 and then drops slightly by 2000. All three Areas increase again

by 2020. The reasons for this are similar to those in the discussion of the previous Subregion. There is a relatively large percentage of cropland which tends to emphasize the effect of land treatment and the increase in urbanization does not become significant until 2020.

The annual sedimentation rate for Subregion F is expected to increase to 152 tons per square mile by 2020. Area 19 has the highest rate in the Subregion with 168 tons per square mile per year. Area 20 is low with an annual rate of 95 tons per square mile.

Problem Areas

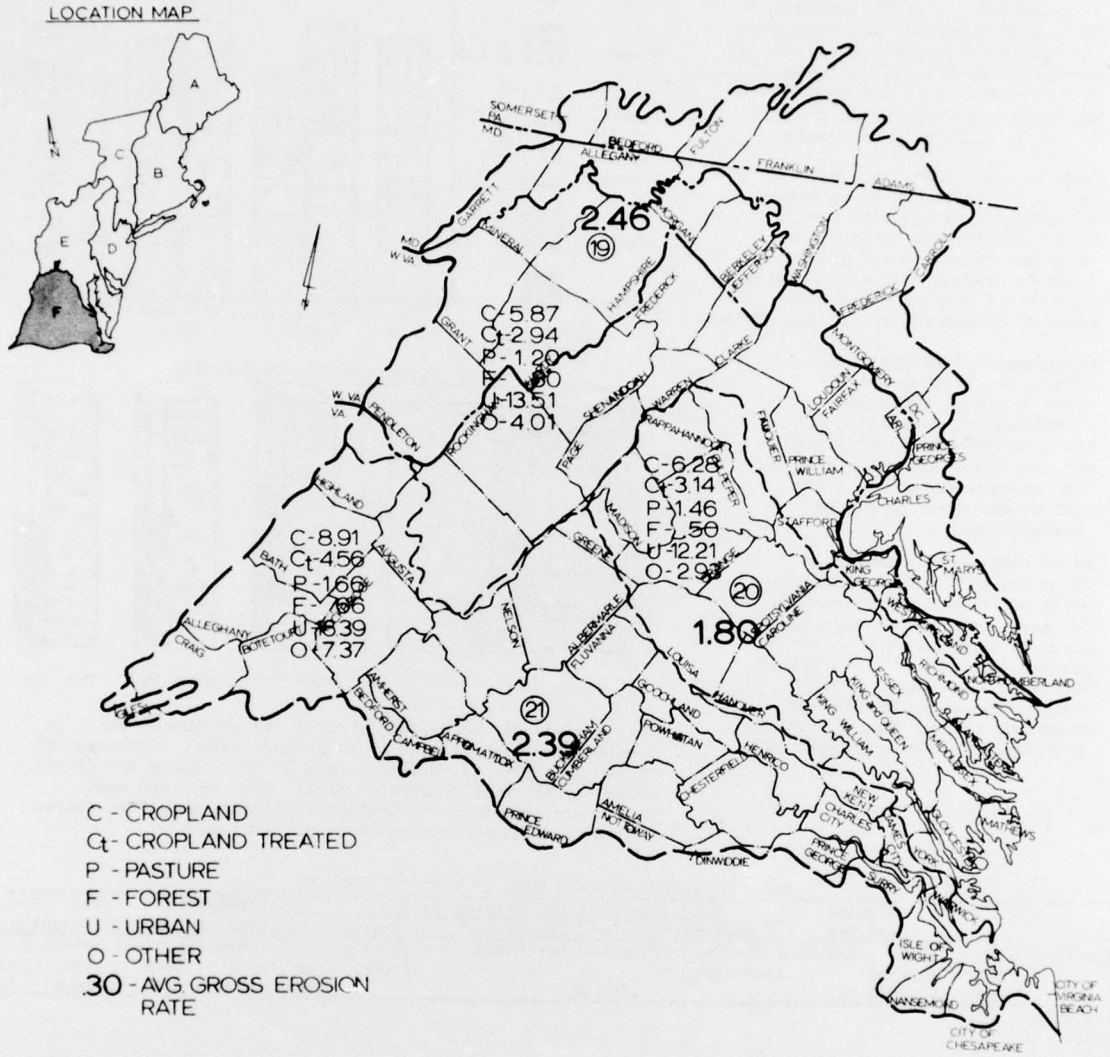
These Areas are all problem areas in soil erosion. The cropland in Area 19 has an erosion rate of 5.87 tons per acre per year; Area 20, 6.28 tons per acre per year; and Area 21, 8.91 tons per acre per year. These areas all exceed the allowable soil loss.

Thirty percent of the sediment from the entire Region comes from Subregion F. Area 19 produces 50 percent of the 4,202,000 cubic yards of sediment in the Subregion. Area 21 produces 1,474,000 cubic yards or 35 percent. The remaining 15 percent comes from Area 20.

Streambank and Shoreline Erosion

In this subregion there are about 25,280 miles of stream channel. Of this amount 1,900 bank miles are considered to be of major consequence and result in $254,000 of annual damage.

Shoreline in this subregion totals about 875 miles, 460 miles of which are considered stable. A substantial part of the stable mileage is in tidal flatland which is somewhat protected from erosive forces of the ocean. The shoreline remaining is not stable and there are 78 miles of critical erosion occurring in this Area.



SUB-REGION F

AREAS (19) - (21)

PROBABLE SOIL LOSS IN TONS PER ACRE PER YEAR

(PRESENT CONDITIONS)

10 0 10 20 30 40 Miles

SCALE

FIGURE Q-12

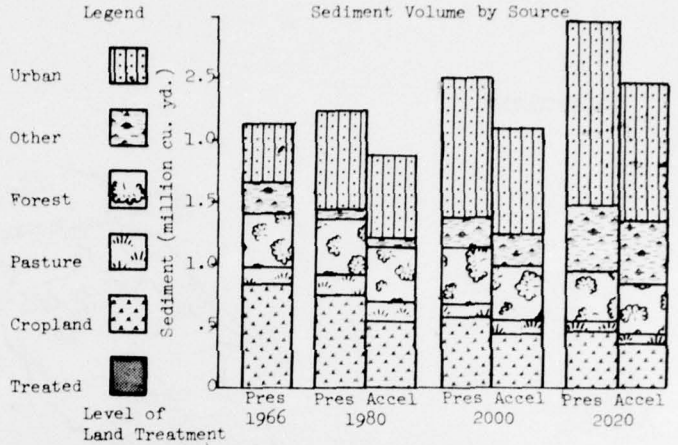
SUBREGION F - AREA 19

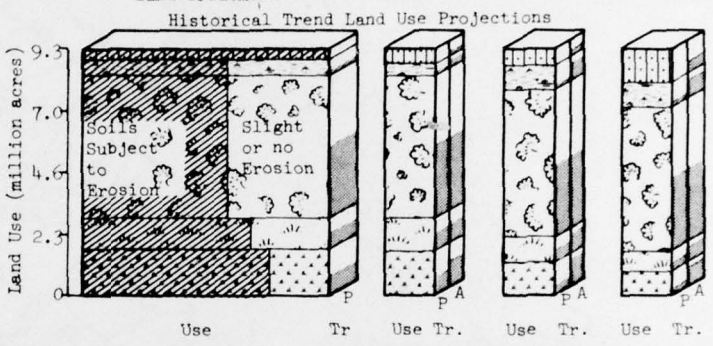
Erosion is the dominant soil hazard on 61% of the Area's 9.3 million acres. An estimated 91% of the sediment comes from these 5.7 million acres. The 35% row crops of the 1.8 million acres of cropland, 47,000 acres of construction areas, and 36,200 acres of critical erosion areas are particularly vulnerable to erosion.

Land use adjustments are needed on 341,000 acres (rates exceeding twice the allowable soil loss). Present protective cover needs to be maintained on 2.0 million acres to prevent excessive erosion. Another 1.5 million acres need adequate treatment for erosion control.

Conservation treatment includes: diversions, stripcropping, cover cropping, roadside stabilization, establishment and re-establishment of grass, and debris basins, grade control structures, and wildlife habitat and development and preservation.

Major bank erosion exists on 950 miles of the 11.7 thousand miles of streams and rivers in the Area. An estimated 28,500 acres of buffer strips would prevent bank overfall and filter sediment. Streambank erosion control includes clearing and snagging, riprap, channel lining, drop spillways and vegetated banks.





This area is characterized by extensive marshland which is inaccessible or developed to a limited extent. Although 69% of the shoreline is unstable, only 3% or 10 miles are classified as being critically unstable. Sand fill and sand fences are needed for protection in local areas. The shoreline will continue to develop residentially.

EROSION CONTROL DEMANDS USED IN PLAN FORMULATION

Objective	Time Frame Year	Planned Land Use: Pre-served 1000 Ac.	Planned Land Use: Adjust 1000 Ac.	Land Treatment for Erosion Control — Conservation Land Treatment: Crop-land 1000 Ac.	Past-ure 1000 Ac.	Forest 1000 Ac.	Other 1000 Ac.	Urban 1000 Ac.	Total 1000 Ac.	Installation: Initial Cost $ Million	Installation: Ave* Ann. Cost $ Million	Streambank Erosion Control: Treat-ment Mile	Streambank Erosion Control: Initial Cost $ Mil.	Shoreline Protection: Treat-ment Mile	Shoreline Protection: Initial Cost $ Mil.
Adequately treated or not feasible to treat	1966	1140		513	379	1636	168	373	3069			10030	**	128	**
NATIONAL EFFICIENCY	1980	1986	138	396	-	-	-	110	506	37.5	7.4	19	.7	<1	-
	2000	-	-	310	-	-	-	193	503	45.8	6.8	48	1.9	<1	-
	2020	-	-	80	-	-	-	310	390	51.9	4.3	48	1.9	<1	-
REGIONAL DEVELOPMENT	1980	1986	341	521	278	8	61	275	1143	116.7	23.6	48	1.9	<1	-
	2000	-	-	408	214	14	206	241	1083	107.7	20.7	95	3.7	1	.4
	2020	-	-	80	41	15	132	388	656	81.9	8.6	95	3.7	1	.4
ENVIRONMENTAL QUALITY	1980	1986	341	521	278	10	61	275	1145	116.9	23.6	95	3.7	24	10.5
	2000	-	-	408	214	16	206	241	1085	107.9	20.7	190	7.4	25	11.0
	2020	-	-	80	41	11	132	388	652	81.4	8.5	190	7.4	2	.9

NOTE: The values shown in the table are incremental. Price Base 1970.
* Initial cost amortized at 5-1/8% project life plus Operation & Maintenance.
** Negligible erosion or stable.

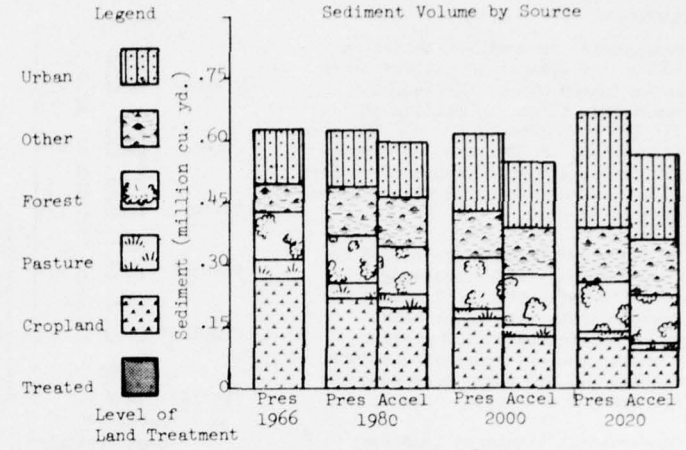
SUBREGION F - AREA 20

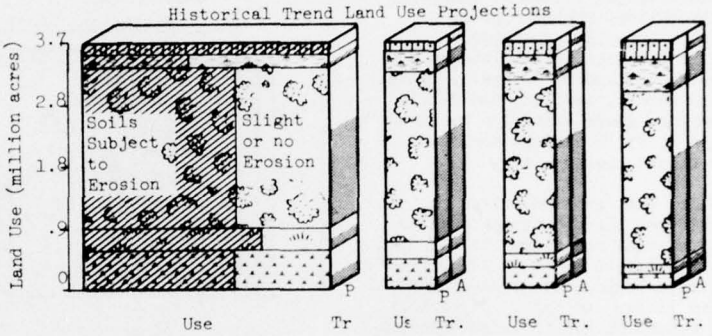
Erosion is the dominant soil hazard on 59% of the Area's 3.7 million acres. An estimated 87% of the sediment comes from these 2.2 million acres. The 35% row crops of the 582,000 acres of cropland, 1,000 acres of construction areas, and 7,000 acres of critical erosion areas are particularly vulnerable to erosion.

Land use adjustments are needed on 76,000 acres (rates exceeding twice the allowable soil loss). Present protective cover needs to be maintained on 616,000 acres to prevent excessive erosion. Another 452,000 acres need adequate treatment for erosion control.

Conservation treatment includes: diversion, stripcropping, cover cropping, roadside stabilization, establishment and re-establishment of grass, trees, and shrubs, settling and debris basins, grade control structures, and wildlife habitat and development and preservation.

Major bank erosion exists on 360 miles of the 4.8 thousand miles of streams and rivers in the Area. An estimated 11,300 acres of buffer strips would prevent bank overfall and filter sediment. Streambank erosion control includes clearing and snagging, riprap, channel lining, drop spillways and vegatated banks.





The shoreline is generally undeveloped with inaccessible tidal flats and marshlands. There are few natural beaches. The man-made beaches are generally small. Nearly 75% of the 342 miles of shoreline are considered stable. Protective measures are needed on 32 miles of critically unstable shore. These areas need sand fill, bulkheading and sand fences.

EROSION CONTROL DEMANDS USED IN PLAN FORMULATION

Objective	Time Frame Year	Planned Land Use: Pre-served: 1000 Ac.	Adjust:	Land Treatment for Erosion Control — Conservation Land Treatment: Crop-land: 1000 Ac.	Past-ure:	Forest:	Other:	Urban:	Total:	Installation Cost: Initial $ Million	Ave.* Ann.	Streambank Erosion Control: Treat-ment: Mile	Initial Cost: $ Mil.	Shoreline Protection: Treat-ment: Mile	Initial Cost: $ Mil.
Adequately treated or not feasible to treat	1966	90		105	124	903	46	116	1294			4360**		254**	
NATIONAL EFFICIENCY	1980	616	34	91	-	-	-	3	94	5.2	1.4	7	.2	1	.6
	2000	-	-	68	-	-	-	39	107	9.5	1.5	18	.6	2	1.2
	2020	-	-	16	-	-	-	60	76	10.0	.9	18	.6	2	1.2
REGIONAL DEVELOPMENT	1980	616	76	117	76	4	74	7	278	24.6	6.1	18	.6	2	1.2
	2000	-	-	87	54	8	75	49	273	26.7	5.2	36	1.2	3	1.8
	2020	-	-	16	14	6	-	75	111	15.2	1.7	36	1.2	3	1.8
ENVIRONMENTAL QUALITY	1980	616	76	117	76	5	74	7	279	24.8	6.2	36	1.2	53	31.6
	2000	-	-	87	54	9	75	49	274	26.8	5.2	72	2.5	54	32.2
	2020	-	-	16	14	4	-	75	109	14.9	1.6	72	2.5	6	3.6

NOTE: The values shown in the table are incremental. Price Base 1970.
* Initial cost amortized at 5-1/8% project life plus Operation & Maintenance.
** Negligible erosion or stable.

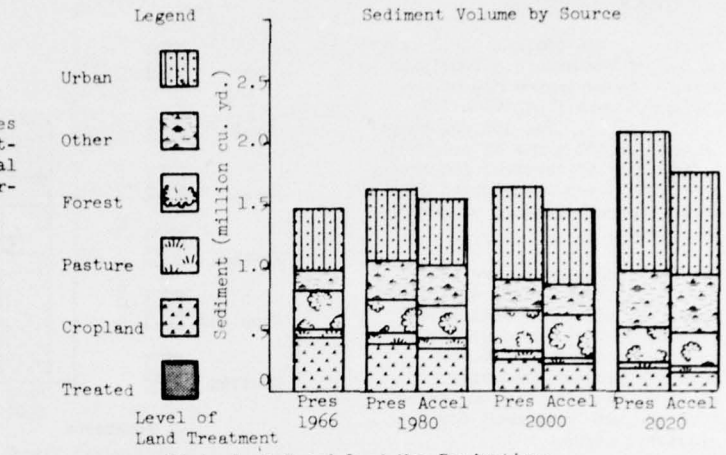
SUBREGION F - AREA 21

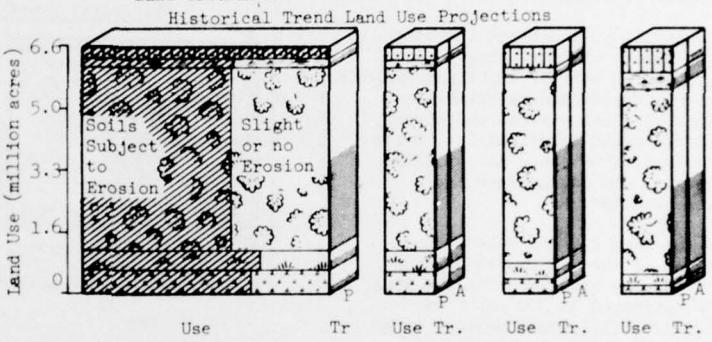
Erosion is the dominant hazard on 58% of the Area's 6.6 million acres. An estimated 87% of the sediment comes from these 3.9 million acres. The 30% row crops of the 636,000 acres of cropland, 2,000 acres of construction areas, and 4,700 acres of critical erosion areas are particularly vulnerable to erosion.

Land use adjustments are needed on 98,000 acres (rates exceeding twice the allowable soil loss.) Present protective cover needs to be maintained on 1.0 million acres to prevent excessive erosion. Another 595,000 acres need adequate treatment for erosion control.

Conservation treatment includes: diversions, stripcropping, cover cropping, roadside stabilization, establishment and re-establishment of grass, trees, and shrubs, settling and debris basins, grade control structures, and wildlife habitat and development and preservation.

Major bank erosion exists on 590 miles of the 8.8 thousand miles of streams and rivers in the Area. An estimated 20,800 acres of buffer strips would prevent bank overfall and filter sediment. Streambank erosion control includes clearing and snagging, riprap, channel lining, drop spillways and vegetated banks.





The diversified shoreline includes shifting sandy areas, narrow beaches, marshland, and residential and commercial areas developed to the waters edge. Half of the shoreline is classified as stable. Protection is needed on 36 miles of critically unstable shoreline. Protective measures include timber groins, vegetative practives, sand fill, and bulkheading.

EROSION CONTROL DEMANDS USED IN PLAN FORMULATION

Objective	Time Frame Year	Planned Land Use: Pre-served 1000 Ac.	Planned Land Use: Adjust 1000 Ac.	Land Treatment for Erosion Control — Conservation Land Treatment 1000 Ac.: Crop-land	Past-ure	Forest	Other	Urban	Total	Installation Cost $ Million: Initial	Installation Cost $ Million: Ave.*	Streambank Erosion Control: Treat-ment Mile	Streambank Erosion Control: Initial Cost $ Mil.	Shoreline Protection: Treat-ment Mile	Shoreline Protection: Initial Cost $ Mil.
Adequately treated or not feasible to treat	1966	113		115	186	1333	86	346	2066			**		**	
NATIONAL EFFICIENCY															
	1980	973	31	152	-	-	-	5	157	8.7	2.4	12	.4	1	1.6
	2000	-	-	108	-	-	-	111	219	22.7	2.8	30	1.0	2	3.2
	2020	-	-	22	-	-	-	175	197	28.1	2.0	30	1.0	2	3.2
REGIONAL DEVELOPMENT															
	1980	973	98	192	147	8	-	13	360	34.9	9.5	30	1.0	2	3.2
	2000	-	-	137	102	14	45	139	437	48.8	8.7	59	1.9	4	6.3
	2020	-	-	22	20	12	106	219	379	47.2	4.6	59	1.9	4	6.3
ENVIRONMENTAL QUALITY															
	1980	973	98	192	147	10	-	13	362	35.1	9.5	59	1.9	27	42.8
	2000	-	-	137	102	16	45	139	439	49.0	8.7	118	3.8	28	44.4
	2020	-	-	22	20	8	106	219	375	46.8	4.6	118	3.8	7	11.1

NOTE: The values shown in the table are incremental. Price Base 1970.
* Initial cost amortized at 5-1/8% project life plus Operation & Maintenance.
** Negligible erosion or stable.

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